



**ADDITIONAL PHASE 2 GROUND
INVESTIGATION: WYNNSTAY
TECHNOLOGY PARK, RUABON**

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Prepared for:

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This report has been prepared by GroundSolve Ltd with all reasonable care and diligence, within the best practice and guidance current at the time of issue within the proposed redline boundary and proposed Site end use as presented by the Client.

This report is confidential to the Client and GroundSolve Ltd accepts no responsibility whatsoever to third parties to whom this report is presented.

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1 INTRODUCTION

GroundSolve Ltd (GSL) was commissioned by Wales and West Housing (“the Client”) to undertake a second phase site investigation and contaminated land risk assessment for an area of land off Wynnstay Lane in Ruabon, Wrexham referred to as Ruabon Business Park (the “Site”).

This report has been devised to generally comply with the relevant principles and requirements of a range of guidance including:

- Part IIA of the Environment Protection Act, 1990;
- BS5930:2015 +A1:2020: “Code of practice for site investigations”;
- BS10175: 2011 +A2:2017 “Investigation of Potentially Contaminated Sites - Code of Practice”;
- The Building Regulations 2010. Part C (HM Government 2013);
- Environment Agency: Land Contamination Risk Management (LCRM), Version 3, October 2020;
- Welsh Local Government Assoc- Development of Land Affected by Contamination Guide for Developers 2017
- Welsh Land Contamination Working Group (WLGA) - Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems

1.1 Proposed Development

The proposed development is comprised of 43No. residential properties with associated parking and garden areas as well as access roads and two areas of open recreational space. See **Figure 1** below.

The site has been granted planning permission (P/2019/0805) by Wrexham Borough County Council. Planning Condition 7 relates to ground conditions and potential contaminated. Permission number P/2023/0793 relates to the discharge of planning condition 7 (Contaminated Land) and other remaining conditions.

There are also 6 industrial properties to the south of the site with associated parking and access road. This area will be part of a separate planning application.

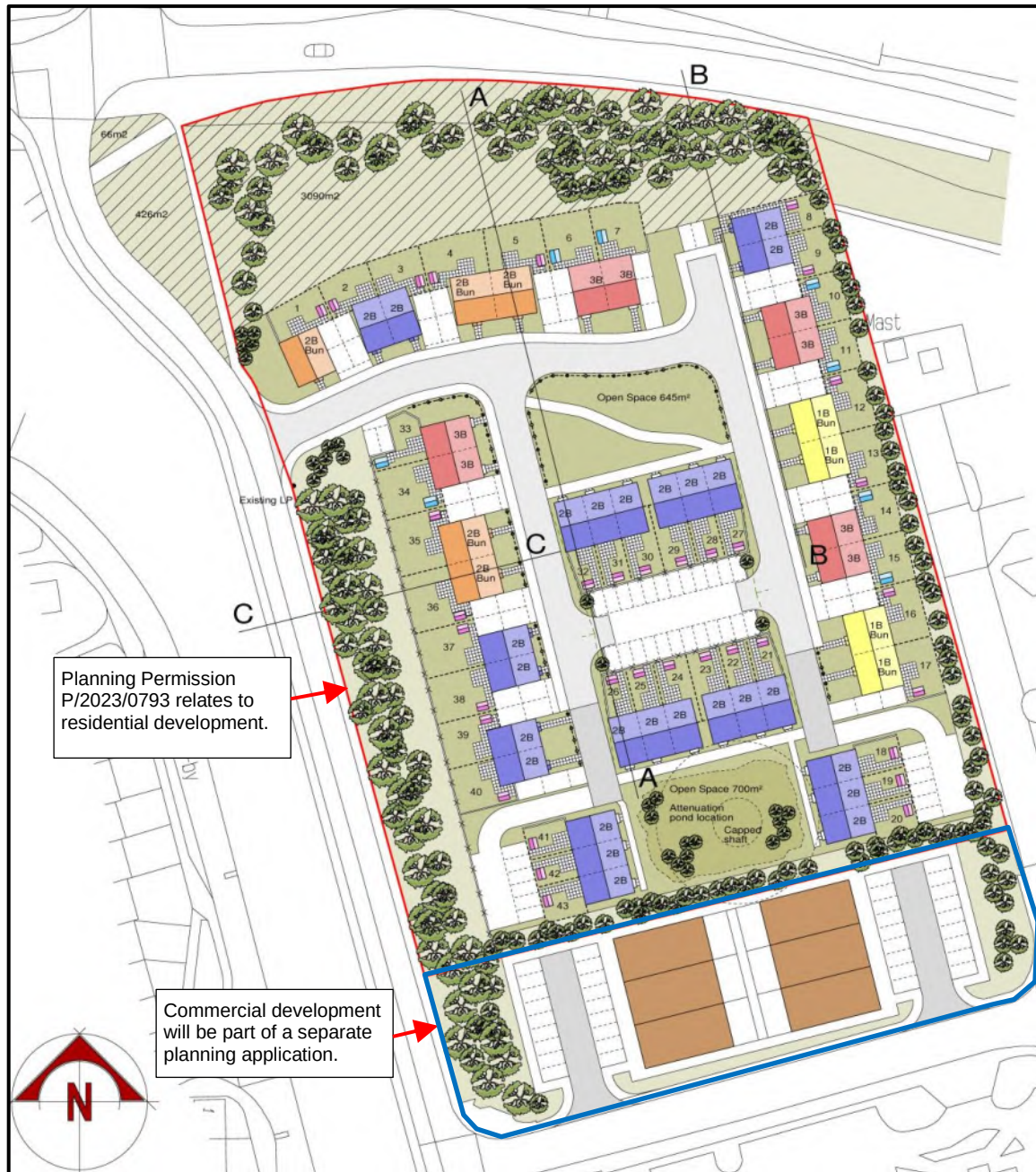


Figure 1 - Extract from Proposed Development Plan – Sean Caddick Architectural 18/1786/03 – Aug19

1.2 Objectives

The investigation objectives are to provide information that will allow the discharge the planning condition stated within P/2023/0793. The purpose of the report is to provide an assessment of the site using published information and conditions at the site in relation to the proposed residential end use.

The findings and conclusions of the risk assessment have been set out and recommendations given for the proposed end use. If there is a subsequent change in the proposed land, the risk assessments and conclusions should be reviewed to determine whether they are still applicable for the revised end use.

This document is a working document and may need to be updated, in agreement with the relevant regulatory bodies, at any stage during development dependent on the conditions encountered. This version of this document is to be issued to regulators for approval (i.e., Wrexham County Borough Council).

1.3 Previous Investigations

The following reports have already been undertaken and will be summarised in Section 3:

- Phase II Geo-environmental Report (Ref:2387, issued October 2020).
- Phase I Preliminary Risk Assessment (Ref: 2949, issued August 2023).
- Phase II Preliminary Risk Assessment (Ref: 2949, issued Sept 2023).

1.4 Limitations

This report has been prepared for the sole use of Wales and West Housing. No other third party may rely upon or reproduce the contents of this report without the written approval of GroundSolve Ltd. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk.

2 SITE DETAILS AND DESCRIPTION

Table 2.1 Current Site Overview.

Site name	Wynnstay Technology Park
Site address	Wynnstay Technology Park, Ruabon, Wrexham LL14 6EN
National Grid Reference (NGR)	329226 343570
Approximate Site area	2.07Ha
Site shape	Roughly Rectangular
General topography and ground levels	The central part of the site is relatively flat with a general slope from north east 126m OD to south west 123m OD. The northern and eastern boundary are formed by raised embankments which are typically 2.0m to 4.0m higher than the rest of the site.

A site visit was undertaken on 13th February 2024. Photographs of the site are presented in **Appendix B**. With the locations of various features detailed.

Table 2.2 – Summary of Description of the Site and its Environs

Current Use:	Derelict unused land
Access	Access is gained from the southeastern boundary
Existing Buildings& Structures	No permanent structures present on site. There is disused site office / steel container, which shows evidence of fire damage inside.
Site Surface	The majority of the site has scrub type vegetation throughout the site overlying very gravelly surface material. There a number of footpaths / access tracked worn into the surface. There is a partial area of gravel surfacing within the SW part of the site. There was no surface water areas present on site.
Vegetation	Generally scrub grass with mature & semi-mature trees along the western and northern site boundaries.
Storage Tanks	Below Ground Tanks: No evidence/none suspected. Above Ground Tanks: None present.
Services	No service information was noted
Asbestos	No potential Asbestos Containing Materials (ACMs) noted in the buildings or on the ground surface.
Waste Disposal/ Materials Storage	No significant areas of waste storage or fly tipping present on site. There is some evidence of fire damage and burnt material present within the container located on the southern boundary. There are two relatively small stockpiles of vegetation present which is understood to originate from recent vegetation clearance.
Surrounding Area	Two commercial sites border to the east (Oakland Egg Packing Plant) and south (Wrexham Mineral Cables). Residential properties are present to the west and an electricity substation is present to the north. The site is bordered by Llangollen Road to the north and Wynnstay Lane to the west. See Figure 2



Figure 2 - Extract from Aerial photography from Groundsure Report

3 PREVIOUS INVESTIGATIONS

The following works have previously been undertaken by GroundSolve:

- Phase II Geo-environmental Report (Ref:2387, issued October 2020).
- Phase I Preliminary Risk Assessment (Ref: 2949, issued August 2023).
- Phase II Preliminary Risk Assessment (Ref: 2949, issued September 2023).

The findings of these reports shall be summarised in the following sections with the full documents included in **Appendix C**.

3.1 Review

A summary of the findings from previous reports is given in **Table 3.1** below:

Table 3.1: Summary of Previous Investigations.

Site History	The earliest available mapping (1873) indicates a shaft located within the southern half, which was associated with the adjacent Wynnstay Colliery with the remainder agricultural fields. By 1899 the shaft is marked as disused, and a secondary air shaft is also identified immediately to the northeast. From 1899 onwards the site is used for the tipping of mining spoil from the colliery via a tramway until its closure in 1962. By 1989 the site and the surrounding areas had extensive earthworks which had reprofiled the ground levels for the site to be redeveloped into Wynnstay Technology Park. The embankment has remained along the western and northern boundaries. The mine shaft was grouted and capped as part of the redevelopment. The site remains broadly undeveloped to the present.
Geological Setting	Made Ground is present typically to 1.0m comprising colliery spoil – gravelly sand / sandy gravel including ash, clinker, coal brick, concrete. The superficial deposits present on site are shown to comprise Glacial Till overlying the solid geology of the Pennine Lower Coal Measures Formation and Pennine Middle Coal Measures Formation (Undifferentiated) - Mudstone, Siltstone and Sandstone. The superficial aquifer on site is classed as Secondary Undifferentiated of low groundwater vulnerability. The bedrock aquifer on site is classed as Secondary A of low groundwater vulnerability.
Mining	The mining risk assessment indicates that the site could be affected by underground mining from 6 coal seams, however these are very deep ranging from 140m to 320m depth, and last worked in 1927. The Coal Authority have indicated that any movement in the ground due to coal mining activity associated with these workings should have stopped by now.

	The coal shaft present to the south of the residential development was grouted and capped in 1990. An associated air shaft was shown to be present on the 1899 mapping however this is not identified within the coal consultant's report included as Appendix D
Waste	Waste material from the past mining activities it likely to be on site in the form of made ground.
Contamination Sources	<u>Onsite</u> Potential contamination features comprise Made Ground from the deposition of colliery spoil and former tramway. During the reprofiling of the site, a significant thickness of colliery spoil was removed from site. Contaminants of concern would be metals and PAHs. No evidence of fuel tanks present on site. Ground gas – no evidence of organic rich Made Ground or drift deposits. There is no evidence of shallow coal mine working on or near the site. The potential for mine gas from the mine shaft present in the south of the residential area is considered very low. The Coal Authority records shows that the shaft was grouted and has a 11m² reinforced concrete cap. An air shaft was identified from the historical mapping. Investigation has carried out to locate this shaft. Further information is given in Section 3.2. <u>Onsite</u> No significant offsite sources of contamination. A substation is present 100m to the north. No risk to the development site. Two commercial properties are 50m to the east and south of the site. No significant sources of contamination. Previous landuse as part of the

3.1 Previous Fieldwork

All the previous phases of fieldwork are summarised below:

Table 3.2 - Summary of previous investigation exploratory holes

Phase of Investigation	Exploratory Hole	Depth to base of strata (mbgl)			Comments
		Made Ground	Glacial Till	Groundwater	
2020	20-TP1	1.10	-		Terminated within the Made Ground
	20-TP1A	2.00	-		Terminated within the Made Ground
	20-TP2	2.30	-		Terminated within the Made Ground
	20-TP3	2.00	-		Terminated within the Made Ground
	20-TP4	1.90	-		Terminated within the Made Ground
	20-WS1	2.00	5.45	1.00	Groundwater encountered perched on cohesive Made Ground
	20-WS2	2.50	5.45	2.00	Groundwater encountered perched on cohesive Made Ground

Phase of Investigation	Exploratory Hole	Depth to base of strata (mbgl)			Comments
		Made Ground	Glacial Till	Groundwater	
	20-WS3	1.50	5.45	1.50	Groundwater encountered perched on surface of Glacial Till
	20-WS4	2.10	4.37	1.50	Groundwater encountered perched on cohesive Made Ground
	20-WS5	2.00	5.35	1.00	Groundwater encountered perched on cohesive Made Ground
	20-WS6	1.90	4.41	1.80	Groundwater encountered perched on surface of Glacial Till
	20-WS7	1.50	5.36	1.50	Groundwater encountered perched on surface of Glacial Till
	20-WS8	2.00	5.45	-	No groundwater encountered. Glacial Till unweathered.
	20-WS9	2.18	-	-	Terminated on obstruction within the Made Ground
	20-WS10	1.70	3.72	1.70	Groundwater encountered perched on surface of Glacial Till
2023	23-TT01	1.75	2.50		No groundwater encountered. Large metal column support present at 1.75m bgl.
	23-TT02	3.00	3.00		No groundwater encountered. Horizontal metal beams present at 2.00m bgl.
	23-TT03	3.00		2.50	Groundwater encountered at 2.50m bgl. Horizontal metal sheets and concrete blocks present at base of pit.
	23-TT04	2.60	3.50		No groundwater encountered. Horizontal timber beam noted at 2.10m bgl.
	23-TT05	2.00	3.50		No groundwater encountered.
	23-TT06	2.65	4.00		No groundwater encountered.
	23-TT07	2.35	4.00		No groundwater encountered.
	23-SA01	2.10	3.25		No groundwater encountered. Soakaway test completed at 1.00m bgl.
	23-SA02	2.00	3.50		No groundwater encountered. Soakaway test completed at 1.00m bgl.
	23-SA03	3.50			No groundwater encountered. Soakaway test completed at 1.00m bgl.
	23-WS01	1.75	4.00		Terminated due to SPT refusal. No groundwater encountered.
	23-WS02	0.90	2.00		Terminated due to SPT refusal. No groundwater encountered.
	23-WS03	1.80	5.00	2.00	Groundwater encountered at 2.00m bgl.
	23-WS04	1.10	4.00		Terminated due to SPT refusal. No groundwater encountered.
	23-WS05	3.00	-		Terminated due to SPT refusal. No groundwater encountered.

3.2 Mining Legacy

The site has a former mine shaft on site, Wynnstay Colliery No.2 Shaft. The shaft was treated and capped by Wrexham BC in the early 90's the details of which are included within the Coal consultant's report in **Appendix D**. Treatment comprised the placement of approximately 550tons of PFA grout into the shaft along with the construction of a 9.60m x 9.60m reinforced concrete cap at ~3.00mbgl. No formal record of the shaft diameter is available however given the cap size, it may have been up to 4.80m in diameter, which ties in with the historical plans.

In addition to the shaft, the 1899 historical plan shows an air shaft some 20m to the north of the main shaft, which on later editions is indicated to be a chimney some 5m in diameter. It is considered that this does not represent a conventional air shaft sunk to the workings. Instead, it is likely that as the “air shaft” had a building next to it then the No 2 shaft was being used as a ventilation shaft at this time, with the building being a fan house sucking air up the shaft. The fan house would be connected to the No.2 shaft via a shallow drift.

The previous investigation completed a series of trial trenches to locate the drift. A total of 3 trenches were completed to locate the air drift and fan house (TT01 – TT03). Pits TT01 & 02 recorded Made Ground to between 1.70 and 2.00m overlying the natural Glacial Till. Both excavations encountered steel and timber shoring along with variations in depth to the underlying Till. It is anticipated these are indicative of the location and depth of the former drift. TT03 encountered the existing shaft cap at 3.00m which is consistent with the recorded details.

In view of the above it is considered that the drift was located at shallow depth and was backfilled as part of the demolition and remediation of the site. Backfilling is unlikely to have been undertaken in a controlled manner and will predominantly comprise the mining spoil loosely tipped into the drift, consequently, it is recommended that the drift is excavated down to the underlying competent strata and the subsequent excavation backfilled with a suitably compacted granular fill.

3.3 Existing Culvert

A drainage strategy report was produced for the site in May 2017 by Tier Consult (TC) for N/S Holdings. This highlighted the presence of a culverted watercourse along the western site boundary, an existing surface water sewer in the estate access road, which discharges into the culvert via a manhole located at the estate entrance junction.

TC also produced a letter report regarding the route of a culvert, which passes beneath the site, which was issued in August 2016. This culvert is considered to be the same one as seen exiting from beneath the spoil mound on the 1873 historical plans.

The route of the culvert was based on a GroundSure report, which drew a straight line between the “Sink” and “Issue” either side of the site. Therefore, TC undertook a Sonde survey in July 2016 to confirm the route of the culvert. It recommended that the development be designed so that no buildings are proposed over the confirmed route of the sewer.

However, the survey by TC shows the culvert must have been diverted to run down the side of the estate road probably at the time Llangollen road was widened and the new access road constructed in the early 1990’s.

This therefore means that the old culvert was either decommissioned at the time of the site's reclamation, or it is still present beneath the site in its abandoned state. The subsequent GSL report completed in 2020 suggested that further investigation was required to determine whether the culvert remains in situ.

As part of the recent investigation a Ground Penetrating Radar (GPR) Survey was completed along the suspected line of the culvert along with completion of 4 trial trenches (TT04 – TT07). Neither survey nor trial trenches found any evidence of the culvert with ground conditions consistent with those encountered within the remaining exploratory holes. In view of this it is considered that the risk posed by the potential for the culvert to remain is reduced to as low as reasonably possible.

4 FIELDWORK

4.1 Introduction

Additional fieldwork was carried out on 13th February 2024. GroundSolve personnel were present to supervise all work, describe the ground encountered, and take samples. Fieldwork procedures were undertaken in accordance with the relevant sections of:

- BS5930:2015 + A1:2020 "Code of Practice for Site Investigations;"
- BS10175:2011 + A2:2017 "Investigation of Potentially Contaminated Sites – Code of Practice."

The investigation included:

- 15 No. hand excavated Trial Pits to a maximum depth of 1.00mBGL,
- Sampling for chemical testing of soils,
- Description of the ground encountered in accordance with BS5930:2015 + A1:2020, Code of Practice for Site Investigations.

The locations of all exploratory holes can be found in Drawing **3060-1-001** along with the locations of the previous investigations.

4.2 Trial Pits

15 No. (HD01 – HD15) hand excavated trial pits were carried out within the existing embankments along the western and northern boundaries and within the development area. The exploratory hole logs are presented in **Appendix E**.

4.3 Samples and Sample Containers

Soil samples for chemical analysis each comprised a pair of samples: a plastic tub for metals and inorganics and an amber glass jar for organics.

Soil samples were stored in cool boxes with ice packs and dispatched directly to the testing laboratory, for all phases of the investigation.

5 GROUND CONDITIONS

5.1 General

The additional site investigations have encountered very similar ground conditions to the previous investigations. All the trial pits terminated within the Made Ground. A summary of the ground conditions encountered during all investigations are given below.

5.2 Anthropogenic Materials

Made ground was present across the whole site to a maximum depth of 3.00m. The made ground was generally comprised a loose to medium dense clayey very sandy gravel or a dark brown sandy gravelly clay. The gravel present in the made ground was a mixture of sandstone concrete, clinker, coal, and brick. No visual or olfactory evidence of contamination was noted during the fieldwork.

5.3 Natural Deposits

Underlying the Made Ground, Devensian (Glacial) Till was recorded throughout the site and proven to a depth of 5.45m bgl.

The Till appears to be in two layers; an upper softened/weathered layer – generally logged as a dark brown sandy gravelly clay and a lower unweathered layer logged as a greyish brown sandy gravelly clay.

Soil classification tests were carried out on the Till samples which revealed all such samples to be a clay of low plasticity, with liquid limits ranging from 27% to 36%, plastic limits ranging from 13% to 19%, a plasticity index between 13% and 20%, and a moisture content ranging from 14% to 31%.

5.4 Bedrock

Bedrock was not encountered during this investigation; however shallow refusals were noted in a number of boreholes onsite.

6 GENERIC QUANTITATIVE RISK ASSESSMENT

6.1 Assessment for the Protection of Human Health

The results of the soil analyses are presented below, where they have been compared to suitable generic assessment criteria (GACs), in order to allow a generic quantitative risk assessment (GQRA) to be carried out for the site and the proposed development.

The Category 4 Screening Levels (C4SLs) published by DEFRA (2014) have been adopted in the first instance, which have been published for six substances to date. Where a C4SL is unavailable, the “Suitable 4 Use Levels” (S4ULs) published by LQM/CIEH (2015) have been adopted.

These criteria have been derived using the CLEA model for a range of standard end-use scenarios and a range of soil organic matter (SOM) contents. It should be noted that the C4SL values are derived on the basis of a “low level of toxicological concern”, while the S4UL values are based on a “tolerable” or “minimal” level of risk. As such, the S4ULs describe a lower level of risk than the C4SLs and are equivalent to the former Soil Guideline Values (SGVs, published by the Environment Agency) and the previous editions of the LQM/CIEH GAC values.

In total within all the previous phases of investigation, there has been up to 23No samples selected for a range of chemical testing. 15No samples of those samples were selected from within the proposed development area. 8No samples were selected within the existing embankments present along the western and northern boundaries.

The GQRA carried out within the development area is based on a soil with a Soil Organic Matter of 1%, for a residential with gardens end use.

A separate GQRA was carried out within the existing embankment and is based on a soil with a Soil Organic Matter of 1%, for a Public Open Space (residential) end use.

A full summary of the chemical test results is presented in **Appendix F**.

6.2 Results

Metals – Development Area

The results from the metal analysis have typically recorded low concentrations below the applicable GACs. However, two samples (20-TP02@0.5m) and 24-HD12 @0.15m) have recorded elevated Arsenic concentrations above the GAC of 37mg/kg.

Metals – Embankment

The results from the metal analysis have recorded typically low concentrations which fall below the applicable GACs for Public Open Space (residential) end use. It should be noted that two samples exceeded the GAC for Arsenic and one for Mercury when compared to residential landuse with plant uptake. It is therefore recommended that these materials are not reused within soft landscaped areas of the new development.

PAHs– Development Area

No exceedances of the applicable PAH GACs were encountered and the PAH concentrations do not represent a significant increased risk to long term human health and give no cause for concern.

PAHs– Embankment

All samples selected for analysis have generally recorded low PAHs and no exceedance of the relevant GACs. It should be noted that one samples exceeded the GAC for Naphthalene when compared to residential landuse with plant uptake.

Petroleum Hydrocarbons (PHC) – Development Area

There were no potential sources of hydrocarbons noted within the Phase 1 desk study. No hydrocarbon impacted material was encountered during the fieldwork.

The speciated Total Petroleum Hydrocarbons (TPH) results have shown very low concentrations, with the majority below the relevant detection limits. The TPH concentrations are below the GAC's and do not represent a significant increased risk to long term human health and give no cause for concern.

Petroleum Hydrocarbons (PHC) – Embankment

BTEX and TPH concentrations were recorded below the detection limit and therefore there was no exceedance of the relevant GACs.

Asbestos

Asbestos can be present in soil as fragments of bulk Asbestos Containing Materials (ACMs) (e.g., asbestos cement sheeting) and also as discrete asbestos fibres within the soil matrix. This investigation has carried out assessments to determine whether both bulk fragments of asbestos and discrete fibres are present in the soil at the site. The asbestos assessment commenced on site with inspection of the Made Ground by our site staff for the presence of bulk ACMs. During the fieldwork no suspected ACMs were identified.

23No samples underwent laboratory assessment to determine whether asbestos fibres or ACMs are present from both the proposed development and embankment area. No asbestos fibres were found in any of the samples (note that the laboratory quantification limit for these samples is 0.001%).

The laboratory analysis confirmed that asbestos was not present in the tested soil samples.

6.3 Assessment for the Protection of Controlled Waters

The total concentrations detected within soil samples are predominantly relatively marginal in human health terms and do not indicate particularly high concentrations which would be indicative of a significant source of contamination to groundwater. There is a significant layer of low permeability Glacial Till below the Made Ground Overall, it is assessed that there is a low possibility of a contaminant linkage between and the underlying groundwater in the Secondary A Aquifer.

Groundsolve believes that the site does not pose a significant risk to Controlled Water because:

- There are low to negligible levels of contaminants present within the Made Ground;
- The site is underlain by low permeability glacial till;
- the site is underlain by non-productive strata;
- the shallow groundwaters at and in the vicinity of the site are not abstracted for human consumption;
- the nearest surface water is >2000m from the site

6.4 Permanent Ground Gases

The intrusive investigation has shown that the shallow ground conditions have recorded relatively thin deposits of Made Ground ranging between 1.5-2.35m in thickness and is generally absent of organic rich material.

The Coal Mining assessment has found no evidence of shallow coal mine working on or near the site. Mining was carried out at depth with the shallowest seam approximately 140m below ground level. The potential for mine gas from the mine shaft present in the south of the residential area is considered very low. The Coal Authority records shows that the shaft was grouted and capped and there is a significant thickness of Glacial Clay.

The air shaft identified from the historical mapping has been investigated and is understood to be a shallow ventilation shaft. The shaft will be relatively shallow and no longer connected within the main shaft. Therefore, the potential for the ventilation shaft to be a ground gas source is considered low.

The Site is located within an area where the radon risk is high, with estimated 5% to 10% of properties affected by radon; therefore, basic radon protective measures are required.

Measured Gas Concentrations

Up to six rounds of gas monitoring have been carried out by GroundSolve in the five gas monitoring wells. The highest flow rates, methane, and carbon dioxide concentrations to date, together with the lowest oxygen levels (i.e., a combination of the worst-case temporal conditions recorded) from the monitoring visits are summarised in **Table 6.1** below:

Table 6.1: Summary of Ground Gas Monitoring

Borehole	Response Zone mbgl	No. of monitoring occasions	Steady State Flow (l/hr)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (% v/v)	Water Level mbgl	Atmospheric pressure readings mb
WS01	1.50	4	0.1*	0.3	3.6	19.1	Dry	998-1005
WS02	1.00	4	0.1*	0.1*	2.5	16.8	Dry	998-1005
WS03	2.00	6	0.1*	0.1*	1.9	17.1	1.82-1.97	967-1005
WS04	1.00	6	0.1*	0.2	2.3	12.9	1.0m-Dry	963-1005
WS05	3.00	6	0.1*	0.2	2.1	15.9	1.35-2.75	967-1005

* limit of detection on gas monitor

Ground Gas Assessment

Background information relating to the origin and production of landfill and ground gases, together with current guidance on the assessment of ground gases, is presented in **Appendix G**. In accordance with this approach and the above measured ground gas levels, it is considered that the worst-case temporal conditions may not have been measured during the monitoring period. However, it is anticipated that the worst-case temporal conditions will not be significantly worse than those presented in **Table 6.1** above. The gas flow rates measured across the site from all the monitoring visits were less than the instrument detection limit of 0.1 l/hr. From Table 8.5 of CIRIA C665 the worst-case Characteristic Situation for the site are as follows:

Table 6.2: Summary Characteristic Gas Situations

Borehole Number	Steady State Flow	CH ₄			CO ₂		
	l/h	% v/v	GSV (l/hr)	Characteristic Situation	% v/v	GSV (l/hr)	Characteristic Situation
WS01	0.1	0.3	0.0003	1	3.6	0.0036	1
WS02	0.1	0.1	0.0001	1	2.5	0.0025	1
WS03	0.1	0.1	0.0001	1	1.9	0.0019	1
WS04	0.1	0.2	0.0001	1	2.3	0.0023	1
WS05	0.1	0.2	0.0002	1	2.1	0.0021	1

Methane concentrations have been recorded at or just above the detection limit. Based on the Ground Gas Assessment it can be seen that the carbon dioxide conditions at the site are the main risk driver regarding the gas conditions. The fieldwork and ground gas concentrations are indicating low gas risk and CS1 conditions. With the absence of any significant gas sources and the CS1 conditions, the proposed development requires no remedial measures for ground gases.

The Site is located within an area where the radon risk is high, with estimated 5% to 10% of properties affected by radon. The site will therefore require basic radon protective measures.

6.5 Risks to Human Health (Construction Phase)

During the construction works there will be a risk from dust to on-site workers and people occupying adjacent properties. Appropriate risk assessments should be carried out by the contractor to allow suitable controls for the mitigation of risk to health of construction workers to be put in place. This risk can be controlled to within acceptable limits by:

- Method statement for site activities including control of dust generation;
- Having adequate site hygiene facilities allowing staff to keep a good level of personal hygiene;
- The method statement shall have a contingency plan which should be implemented if the presence of significantly elevated levels of lead is suspected in groundworks; and
- Only permitting smoking or eating on site in appropriate pre-designated areas.

As a minimum it is anticipated the works will be undertaken in accordance with BRE best practise guidance, and that the following measures will be introduced to assist with control of dust generation during the groundworks phase of the works:

- Access roads and any stockpiles created during groundworks should be regularly damped down with water;
- Vehicles used to transport materials/wastes and aggregates should be enclosed or tarpaulined;
- Vehicle movements and speed should be kept to a minimum within the site ;
- Dust generating equipment (e.g., mobile crushing and screening equipment) should be located to minimise potential nuisance impacts to receptors as far as practicable; and
- Minimising drop heights of all loading and unloading activities that involve the transfer of soils and demolition materials.

6.6 Conceptual Site Model

The proposed development comprises 43No. residential properties along with associated parking and gardens with two areas of communal open space.

It is understood that the levels on site are to be raised above existing ground level. The western and northern boundaries currently have embankments 2.0m to 4.0m above the rest of the site. It is understood that these embankments will be reprofiled as part of the redevelopment.

The conceptual site model has been updated since the Phase 1 Preliminary Risk Assessment, as the findings of the Phase 2 site investigation revealed the following general downward succession:

- Site surface: Reworked colliery material / sandy gravel/ gravelly Sand. Typically absence of topsoil;
- Made Ground; Reworked colliery material varying between sandy gravel/ gravelly Sand and reworked gravelly clay typically ranging between 1.5m to 2.35m.
- Devensian Till: generally encountered as a dark brown sandy gravelly clay and a greyish brown sandy gravelly clay.

The potential contamination at the site has been assessed using the contaminant-pathway-receptor linkage approach.

Table 6.3: Summary of Contaminant Linkages

Receptor Group	Pollution Source	
	Hotspots	Pervasive
Human Health	Slight localised exceedance of Arsenic within 20-WS5 and HD12 located in the central western part of the site.	Nil, subject to EHO approval with regards to slight localised exceedance of Arsenic. Elevated concentrations recorded within embankment material indicates that these materials are not suitable for reuse within the proposed gardens areas of the new development.
Plant Life	None	None
Controlled Waters	No unacceptable contamination, subject to confirmation from NRW	
Water Supply Pipe Material Assessment	No special precautions required, use of PE pipe is deemed permissible	
Design of below ground concrete	No special precautions are required at the site for the design of concrete in terms of the durability and structural performance	
Human health / property (from ground gases)	Basic Radon protection measures are required. With regards to permanent ground gases, no gas protection measures are required (i.e. Characteristic Situation 1/NHBC Green conditions apply).	

The results of site investigation and laboratory analysis generally recorded low concentrations of metals, PAHs, TPHs and asbestos all typical from soils that comprise ash, clinker, coal fragments. There have been two samples which recorded elevated concentrations for arsenic from within the existing development area.

The investigations have shown that the site is absent or has minimal thicknesses of topsoil/ subsoil. As part of the new development it is proposed to reprofile the embankments along the western and northern boundary with the recovered material reused on site to raise existing ground levels. However, due to the concentrations of arsenic, mercury and Naphthalene these materials would only be suitable for reused in hard landscaped areas i.e. under buildings, roads and paths, the material is not suitable for reuse within the top 600mm of private gardens and soft landscaped areas.

It should be possible to utilise site won materials for soft landscaping areas however this will be subject to the following restrictions:

- Materials used must be recovered from within the site itself rather than the embankments.
- Exploratory Holes 20-TP02 and 24-HD12 showed elevated levels of arsenic indicating a localised hotspot as such materials recovered from this area should not be used below soft land scaping and gardens.
- The recovered materials will not be suitable as a growing medium and will require capping with a suitably tested and imported topsoil and subsoil.

Should it be proposed to utilise material recovered from the embankments and/or the area around 20-TP02 and 24-HD12 then the following remedial actions will be required:

- Remediation is only required below areas of gardens/soft landscaping to enable provision of uncontaminated cover soils in areas of garden/soft landscaping (minimum of 600 mm).
- Provision of a clean cover system in areas of gardens and soft landscaping. This should comprise of a 600 mm thick cover of 'clean and inert' capping (comprising 450 mm subsoil and 150 mm topsoil).

Radon Protection Measures

The new development will require basic radon protective measures.

Whilst unexpected contamination is not anticipated, the proposed development could encounter previously unrecorded hotspots of contaminants. These will be assessed and mitigated in accordance with current good practice.

6.7 Remediation Strategy

The risk assessments have concluded that remediation measures are only required if it is proposed to utilise those materials identified as exceeding the required GAC for residential with plant uptake, namely the embankment fill and the material recovered around 20-TP02 and 24-HD12.

Should this be proposed then a separate Remediation Strategy document will be required in accordance with procedures in Wrexham BC 'The Development of Land Affected by Contamination' document. In general terms, any works proposed on site should ensure the Site is 'suitable for use'. The Remediation Strategy shall state the required remediation targets, identify technically feasible remedial options and then provide a detailed evaluation of the options. in accordance with Part IIA of the Environmental Protection Act, i.e. contamination remaining on site:

- Does not present a significant risk of significant harm to identified receptors.
- Does not cause significant pollution of controlled waters.

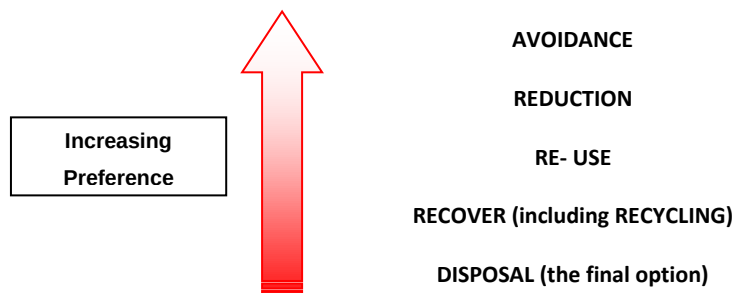
Remediation is only required below areas of gardens/soft landscaping to enable provision of uncontaminated cover soils (minimum of 600 mm). It is proposed that all Made Ground is removed and replaced with a minimum 600mm thick of topsoil / subsoil (comprising 450 mm subsoil and 150 mm topsoil).

In addition to the above, basic Radon protection measures are required for the new developments. The installation of the protection measures will be inspected and independently verified.

7 WASTE ASSESSMENT

7.1 Waste Hierarchy

In accordance with government guidance, it is required that the production and disposal of waste is managed in accordance with the following hierarchy of preference:



Site visits have indicated there is no significant quantities of fly tipping across the site. :

As with most developments, there will be waste materials produced from excavations for drainage/services. Where possible, these arisings should be incorporated into reprofiling the site levels on site with the arisings being separated into Made Ground and Glacial Till as they are excavated in order to facilitate the re-use.

7.2 Waste Characterisation and Classification

If there is a portion of excess soil this will then have to be sent to a suitable landfill site. A two-phase approach is required comprising:

- Waste Characterisation; and
- Waste Classification (Waste Acceptance Criteria).

Waste Characterisation

The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste classification. The results of this assessment indicate that there are no materials encountered during the investigation that are classified as hazardous.

Waste Classification

In order to determine whether soils can be sent to a licensed landfill for disposal further testing is required comprising landfill Waste Acceptance Criteria (WAC) analysis for both total concentrations for certain chemicals and for leachate analysis. No WAC testing was carried out as part of this investigation. WAC testing will have to be carried out to confirm the landfill waste classification and if any pre-treatment is required. This is best carried out once all material to be disposed of is stockpiled, and volumes can be accurately assessed. It should be noted that natural clay can be classified as Inert Waste 17 05 04: Soil and stones only (excluding topsoil, peat, soil, and stones).

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BGS Geology of Britain Viewer <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

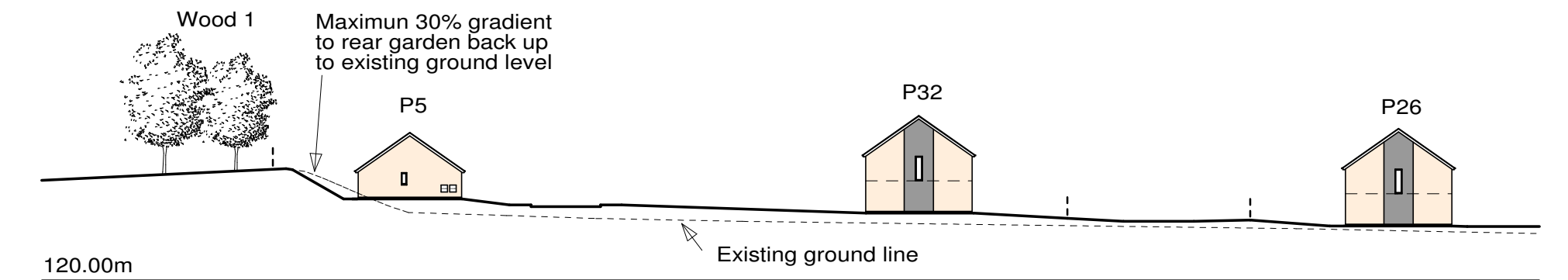
9 DEFINITIONS

AOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GQRA	Generic Quantitative Risk Assessment
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
ppm	Parts per million
ppmv	Parts per million by volume
SAC	Special Area of Conservation
SPZ	Source Protection Zone (see Error! Reference source not found.)
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest

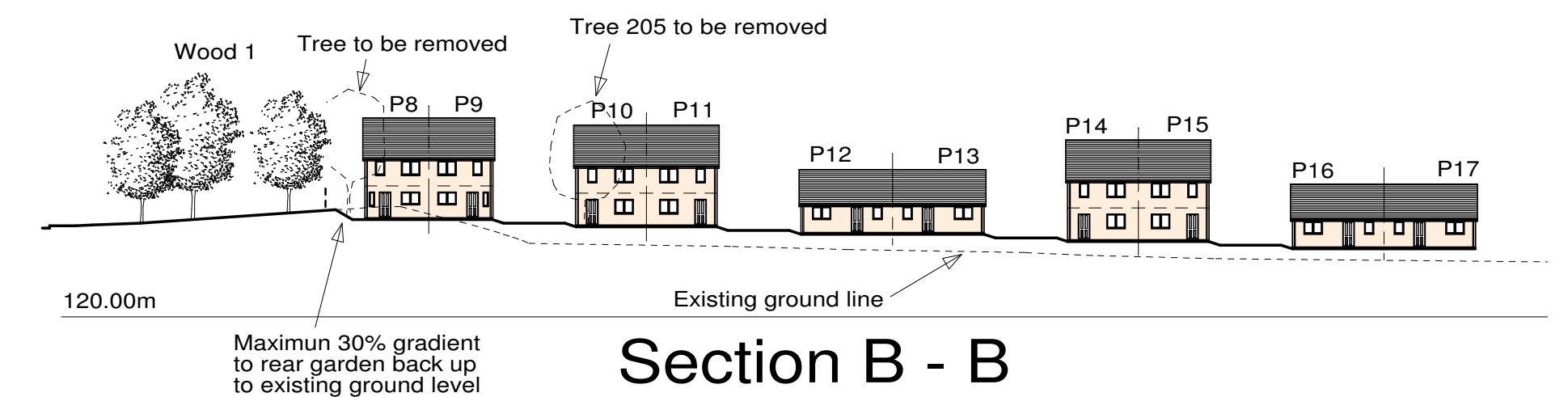
APPENDIX A – DRAWINGS



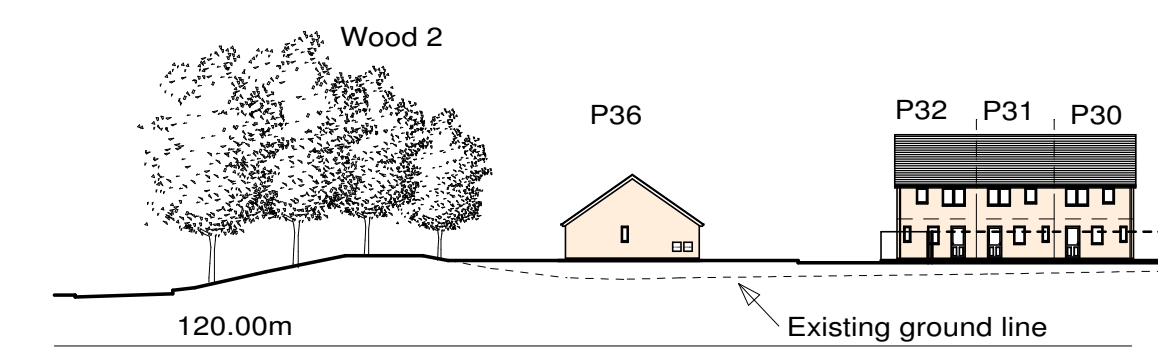
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Section A - A



Section B - B



Section C - C

Open Space total 1331m²

Woodland area total 3582m²

26No. 2 Bedroom Social Housing Dwelling @ 84m²

8No. 3 Bedroom Social Housing Dwelling @ 95m²

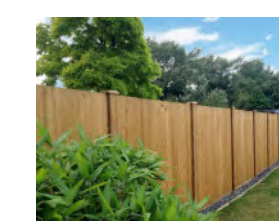
4No. 1 Bedroom Social Bungalow @ 51m²

5No. 2 Bedroom Social Bungalow @ 58m²

Timber knee rail



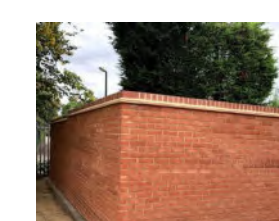
2.0m high timber fence



2.0m combination brick wall and fence panels



2.0m brick wall



Garden shed with tongue and groove cladding and tongue and groove roof boarding.

2.1x1.5m (3.15m²) garden shed

2.4x1.8m (4.32m²) garden shed



Revision:		
A	Layout amended following comments from pre app consultation.	18/09/19
B	Site sections added.	15/01/20
C	Layout amended.	23/02/20
D	Layout amended.	25/02/20
E	Boundary details added.	02/03/20
F	Porches added and adjustments.	08/03/20
G	Garden sheds added.	16/06/21
H	Garden sheds adjusted.	08/07/21

Sean Caddick Architectural
13 Belvidere Walk
Shrewsbury
SY2 5LT
[email: seancaddick@live.co.uk](mailto:seancaddick@live.co.uk)
Tel: 07971 166529

Client:
Cartell GO Ltd

Project:
Residential Development
Wynnstey Park
Ruabon
Wrexham

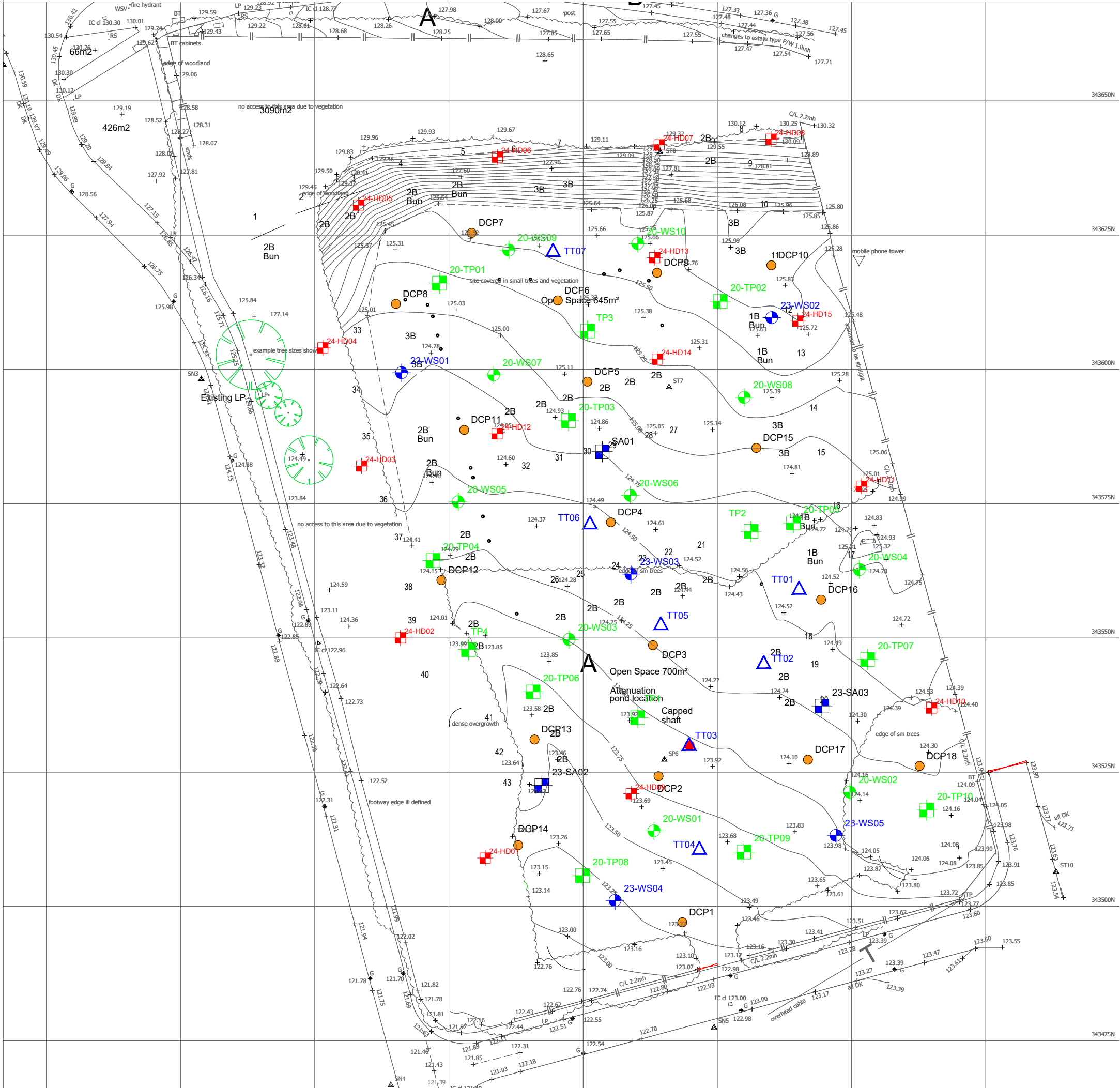
Drawing title:
Proposed Block Plan

Scale:
1:500 @ A1

Date:
August 2019

Drawing number:
18/1786/03

Revision:
H



Legend

- Site Boundary
- 2020 Investigations
 - Trial Pit Locations
 - Borehole Locations
 - DCP Locations
- 2023 Site Investigation
 - Windowless Sample Locations
 - Soakaway Locations
 - TT Locations
- 2024 Site Investigation
 - Trial Pits

A		
Revision	Description	Date

GroundSolve Ltd
Consulting Geotechnical Engineers

Unit 1, Charter Court
Well House Barns
Chester Road Bretton
Flintshire CH4 0DH

Tel: 01244 661361
Fax: 01244 661289

Job Title
**Wynnstey Technology Park
Ruabon, Wrexham**

Drawing Title
Exploratory Hole Location Plan

Drawing Scale @ A3	Drawn By JT	Approved By SF
Drawing Status Draft	Date of Issue 02/24	
Drawing No 3060-1-001	Revision	



Legend

Site Boundary

2020 Investigations

Trial Pit Locations

Borehole Locations

DCP Locations

2023 Site Investigation

Windowless Sample Locations

Soakaway Locations

TT Locations

2024 Site Investigation

Trial Pits

A		
Revision	Description	Date

GroundSolve Ltd
Consulting Geotechnical Engineers

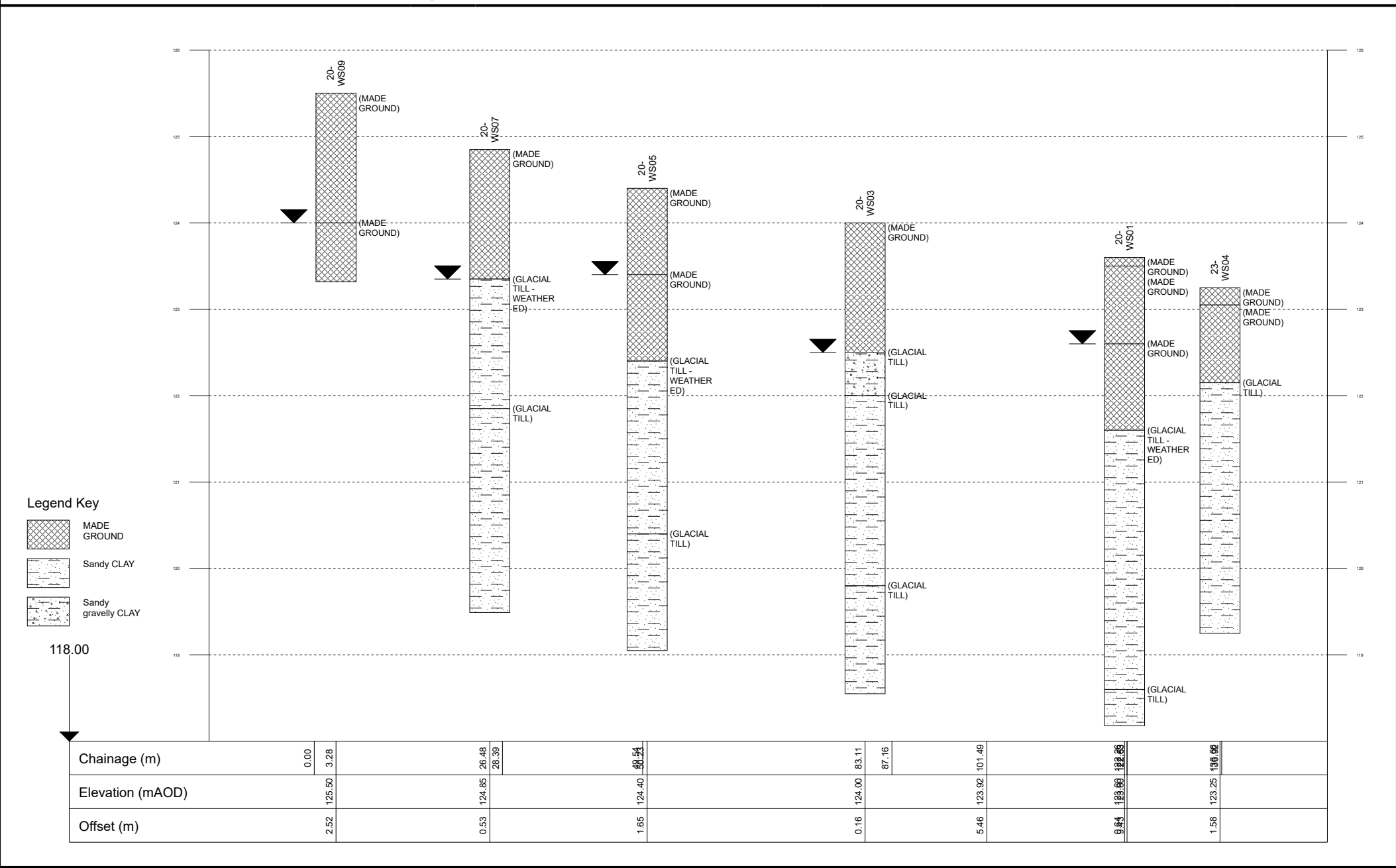
Unit 1, Charter Court
Well House Barns
Chester Road Bretton
Flintshire CH4 0DH

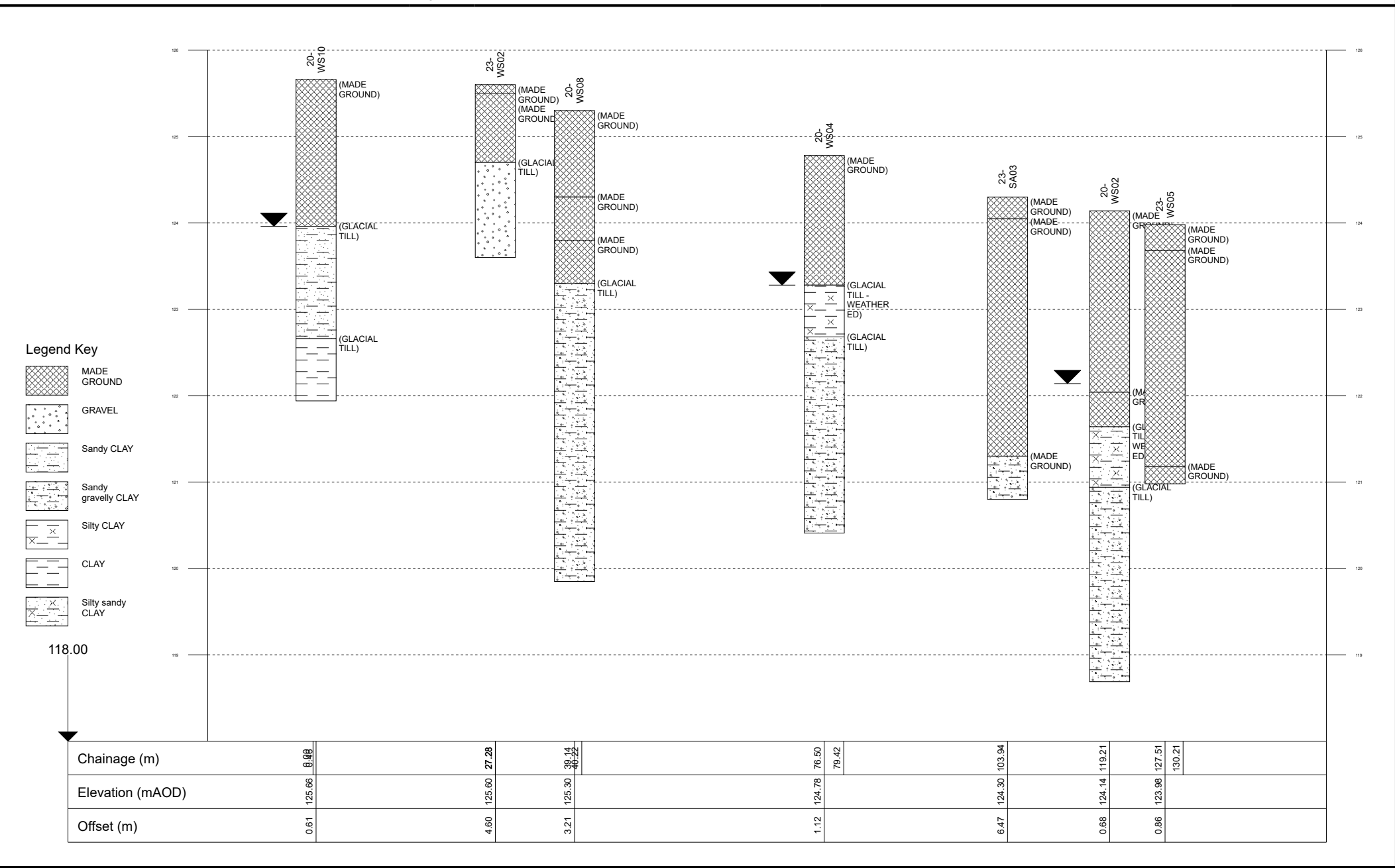
Tel: 01244 661361
Fax: 01244 661289

Job Title
**Wynnstey Technology Park
Ruabon, Wrexham**

Drawing Title
**Exploratory Hole Location Plan
with Development Plan**

Drawing Scale @ A3	Drawn By JT	Approved By SF
Drawing Status Draft	Date of Issue 02/24	
Drawing No 3060-2-001	Revision	





APPENDIX B – SITE PHOTOGRAPHS

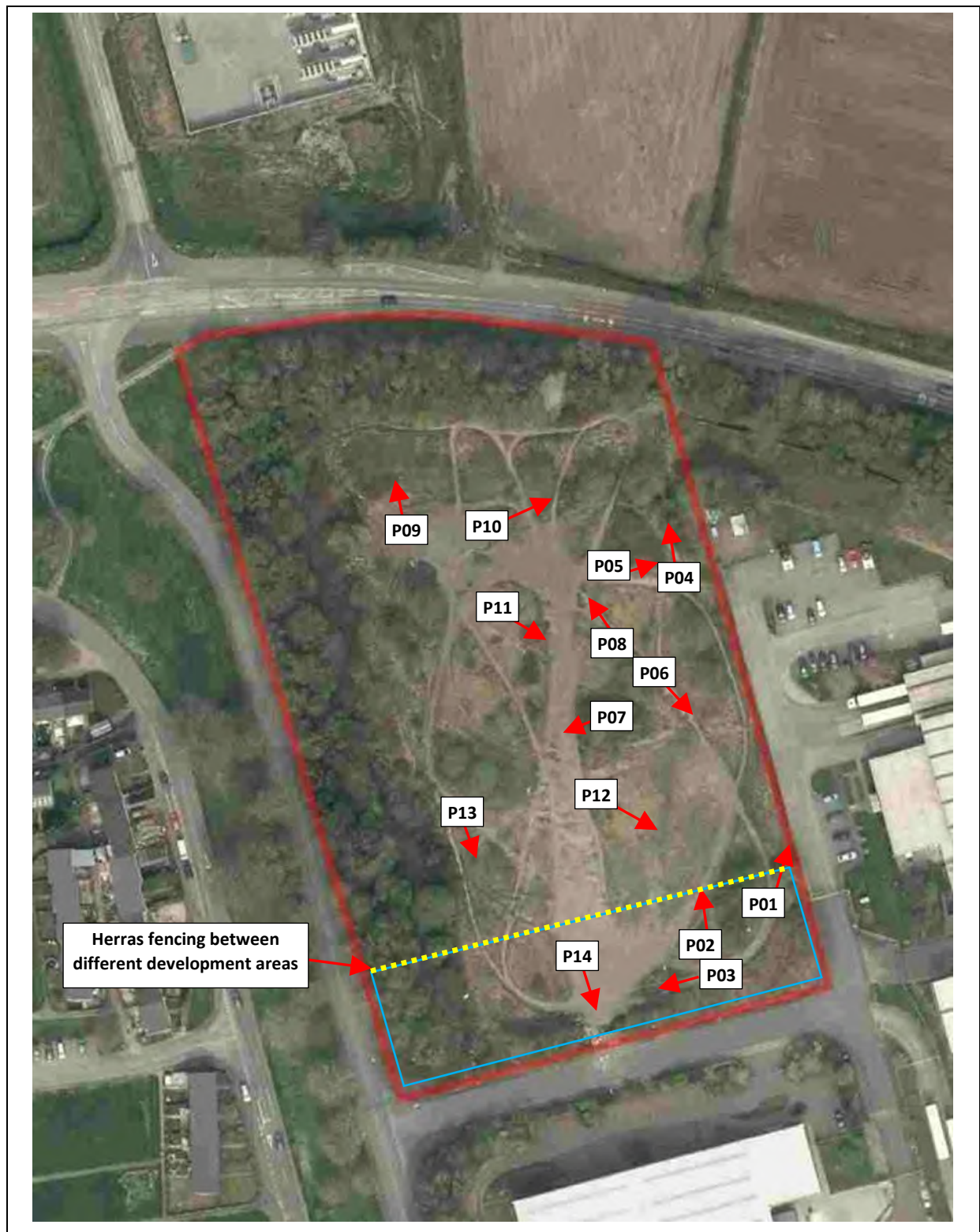




Photo 1 – Looking north from the southern part of the site



Photo 2 – Looking north from the southern part of the site



Photo 3 – Looking west within southern part of site



Photo 4 – Looking north from NE part of the site.



Photo 5 – Looking east towards Oaklands Egg Packing Plant



Photo 6 – Looking south from NE corner of site



Photo 7 – Looking west from NE corner of site



Photo 8 – Looking north towards NW corner of site



Photo 9 – Looking north from NW corner



Photo 10 – Looking east from northern part of site



Photo 11 – Looking Southwest from centre of the site



Photo 12 – Looking southeast from centre of the site



Photo 13 – Looking south along western boundary



Photo 14 – Old container present along southern boundary. Evidence of fire damage. Burnt ash material present inside container. No evidence of any impact outside the container.

APPENDIX C – COAL AUTHORITY CONSULTANTS REPORT



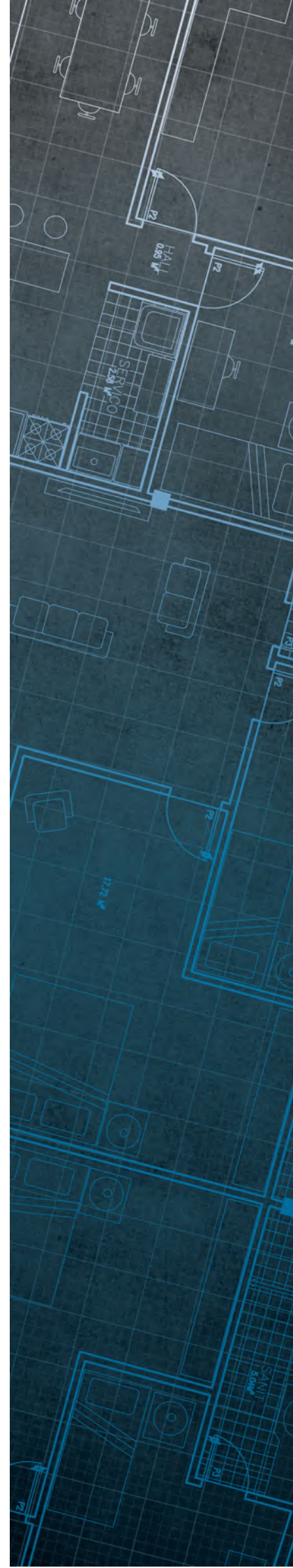
The Coal
Authority

Consultants Coal Mining Report

Street Record, Wynnstay Technology
Park, Ruabon
Wrexham
LL14 6EN

Date of enquiry:	5 March 2024
Date enquiry received:	5 March 2024
Issue date:	5 March 2024

Our reference:	51003409313001
Your reference:	GS-UX1-9QG-978-BKA



Consultants

Coal Mining Report

This report is based on and limited to the records held by the Coal Authority at the time the report was produced.

Client name

GROUNDSURE LIMITED

Enquiry address

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Wrexham
LL14 6EN

How to contact us

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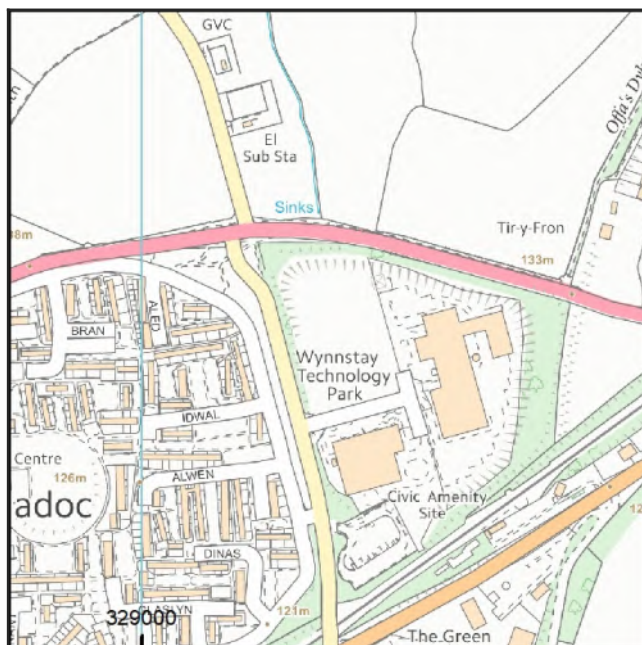
www.groundstability.com

 @coalauthority

 /company/the-coal-authority

 /thecoalauthority

 /thecoalauthority



Approximate position of property



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Section 1 – Mining activity and geology

Past underground mining

Colliery	Seam	Mineral	Coal Authority reference	Depth (m)	Direction to working	Dipping rate of seam worked (degrees)	Dipped direction of seam worked	Extraction thickness (cm)	Year last mined
unnamed	QUAKER	Coal	3AD1	136	Beneath Property	10.7	South-East	170	1927
WYNNSTAY	MAIN	Coal	38SA	163	Beneath Property	14.0	South-East	240	1927
unnamed	STONE	Coal	38VO	222	Beneath Property	14.0	South-East	150	1927
unnamed	RUABON YARD (SOFT 5 QTRS)	Coal	382Q	246	Beneath Property	14.0	East	110	1927
WYNNSTAY	RED (DURBOG)	Coal	3853	283	South-East	16.4	South-East	70	1927
unnamed	WALL AND BENCH	Coal	380K	292	Beneath Property	4.0	South-East	110	1927
unnamed	WALL AND BENCH	Coal	380M	318	South-East	14.0	South-East	110	1927

Probable unrecorded shallow workings

None.

Spine roadways at shallow depth

No spine roadway recorded at shallow depth.

Mine entries

Entry type	Reference	Grid reference	Treatment description	Mineral	Conveyancing details
Shaft	329343-194	329224 343527	This entry was initially filled with colliery shale by the owners circa 1970 to an unknown specification. In March 1990 Wrexham Maelor Borough Council provided information that they had treated and capped this shaft in accordance with British Coal recommendations. They state that 515 tonne of 9:1 PFA/OPC grout was pressure injected into the shaft fill. The shaft was then covered with a 9.6m X 9.6m X 600mm thick reinforced concrete cap situated in competent clay some 2.6m BGL. Level of top of cap is 121.15m A.O.D.	Coal	Tsuda (UK) Co. Ltd 05/09/1991

Abandoned mine plan catalogue numbers

The following abandoned mine plan catalogue numbers intersect with some, or all, of the enquiry boundary:

16713	PO0	9550
-------	-----	------

Please contact us on 0345 762 6848 to determine the exact abandoned mine plans you require based on your needs.

Outcrops

No outcrops recorded.

Geological faults, fissures and breaklines

Please refer to the 'Summary of findings' map (on separate sheet) for details of any geological faults, fissures or breaklines either within or intersecting the enquiry boundary.

Fault under or close to the property recorded.

Opencast mines

None recorded within 500 metres of the enquiry boundary.

Coal Authority managed tips

None recorded within 500 metres of the enquiry boundary.

Section 2 – Investigative or remedial activity

Please refer to the 'Summary of findings' map (on separate sheet) for details of any activity within the area of the site boundary.

Site investigations

None recorded within 50 metres of the enquiry boundary.

Remediated sites

None recorded within 50 metres of the enquiry boundary.

Coal mining subsidence

The Coal Authority has not received a damage notice or claim for the subject property, or any property within 50 metres of the enquiry boundary, since 31 October 1994.

There is no current Stop Notice delaying the start of remedial works or repairs to the property.

The Coal Authority is not aware of any request having been made to carry out preventive works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

Mine gas

None recorded within 500 metres of the enquiry boundary.

Mine water treatment schemes

None recorded within 500 metres of the enquiry boundary.

Section 3 – Licensing and future mining activity

Future underground mining

None recorded.

Coal mining licensing

None recorded within 200 metres of the enquiry boundary.

Court orders

None recorded.

Section 46 notices

No notices have been given, under section 46 of the Coal Mining Subsidence Act 1991, stating that the land is at risk of subsidence.

Withdrawal of support notices

The property is not in an area where a notice to withdraw support has been given.

The property is not in an area where a notice has been given under section 41 of the Coal Industry Act 1994, cancelling the entitlement to withdraw support.

Payments to owners of former copyhold land

The property is not in an area where a relevant notice has been published under the Coal Industry Act 1975/Coal Industry Act 1994.

Section 4 – Further information

The following potential risks have been identified and as part of your risk assessment should be investigated further.

Future development

If development proposals are being considered, technical advice relating to both the investigation of coal and former coal mines and their treatment should be obtained before beginning work on site. All proposals should apply specialist engineering practice required for former mining areas. No development should be undertaken that intersects, disturbs or interferes with any coal or coal mines without first obtaining the permission of the Coal Authority.

MINE GAS: Please note, if there are no recorded instances of mine gas within 500m of the enquiry boundary, this does not mean that mine gas is not present within the vicinity. The Coal Authority Mine Gas data is limited to only those sites where a Mine Gas incident has been recorded. Developers should be aware that the investigation of coal seams, mine workings or mine entries may have the potential to generate and/or displace underground gases. Associated risks both to the development site and any neighbouring land or properties should be fully considered when undertaking any ground works. The need for effective measures to prevent gases migrating onto any land or into any properties, either during investigation or remediation work, or after development must also be assessed and properly addressed. In these instances, the Coal Authority recommends that a more detailed Gas Risk Assessment is undertaken by a competent assessor.

Development advice

The site is within an area of historical coal mining activity. Should you require advice and/or support on understanding the mining legacy, its risks to your development or what next steps you need to take, please contact us.

For further information on specific site or ground investigations in relation to any issues raised in Section 4, please call us on 0345 762 6848 or email us at groundstability@coal.gov.uk.

Section 5 – Data definitions

The datasets used in this report have limitations and assumptions within their results. For more guidance on the data and the results specific to the enquiry boundary, please **call us on 0345 762 6848** or **email us at groundstability@coal.gov.uk**.

Past underground coal mining

Details of all recorded underground mining relative to the enquiry boundary. Only past underground workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination, will be included.

Probable unrecorded shallow workings

Areas where the Coal Authority believes there to be unrecorded coal workings that exist at or close to the surface (less than 30 metres deep).

Spine roadways at shallow depth

Connecting roadways either, working to working, or, surface to working, both in-seam and cross measures that exist at or close to the surface (less than 30 metres deep), either within or within 10 metres of the enquiry boundary.

Mine entries

Details of any shaft or adit either within, or within 100 metres of the enquiry boundary including approximate location, brief treatment details where known, the mineral worked from the mine entry and conveyance details where the mine entry has previously been sold by the Authority or its predecessors British Coal or the National Coal Board.

Abandoned mine plan catalogue numbers

Plan numbers extracted from the abandoned mines catalogue containing details of coal and other mineral abandonment plans deposited via the Mines Inspectorate in accordance with the Coal Mines Regulation Act and Metalliferous Mines Regulation Act 1872. A maximum of 9 plan extents that intersect with the enquiry boundary will be included. This does not infer that the workings and/or mine entries shown on the abandonment plan will be relevant to the site/property boundary.

Outcrops

Details of seam outcrops will be included where the enquiry boundary intersects with a conjectured or actual seam outcrop location (derived by either the British Geological Survey or the Coal Authority) or intersects with a defined 50 metres buffer on the coal (dip) side of the outcrop. An indication of whether the Coal Authority believes the seam to be of sufficient thickness and/or quality to have been worked will also be included.

Geological faults, fissures and breaklines

Geological disturbances or fractures in the bedrock. Surface fault lines (British Geological Survey derived data) and fissures and breaklines (Coal Authority derived data) intersecting with the enquiry boundary will be included. In some circumstances faults, fissures or breaklines have been known to contribute to surface subsidence damage as a consequence of underground coal mining.

Opencast mines

Opencast coal sites from which coal has been removed in the past by opencast (surface) methods and where the enquiry boundary is within 500 metres of either the licence area, site boundary, excavation area (high wall) or coaling area.

Coal Authority managed tips

Locations of disused colliery tip sites owned and managed by the Coal Authority, located within 500 metres of the enquiry boundary.

Site investigations

Details of site investigations within 50 metres of the enquiry boundary where the Coal Authority has received information relating to coal mining risk investigation and/or remediation by third parties.

Remediated sites

Sites where the Coal Authority has undertaken remedial works either within or within 50 metres of the enquiry boundary following report of a hazard relating to coal mining under the Coal Authority's Emergency Surface Hazard Call Out procedures.

Coal mining subsidence

Details of alleged coal mining subsidence claims made since 31 October 1994 either within or within 50 metres of the enquiry boundary. Where the claim relates to the enquiry boundary confirmation of whether the claim was accepted, rejected or whether liability is still being determined will be given. Where the claim has been discharged, whether this was by repair, payment of compensation or a combination of both, the value of the claim, where known, will also be given.

Details of any current 'Stop Notice' deferring remedial works or repairs affecting the property/site, and if so the date of the notice.

Details of any request made to execute preventative works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991. If yes, whether any person withheld consent or failed to comply with any request to execute preventative works.

Mine gas

Reports of alleged mine gas emissions received by the Coal Authority, either within or within 500 metres of the enquiry boundary that subsequently required investigation and action by the Coal Authority to mitigate the effects of the mine gas emission. Please note, if there are no recorded instances of mine gas reported, this does not mean that mine gas is not present within the vicinity. The Coal Authority Mine Gas data is limited to only those sites where a Mine Gas incident has been recorded.

Mine water treatment schemes

Locations where the Coal Authority has constructed or operates assets that remove pollutants from mine water prior to the treated mine water being discharged into the receiving water body.

These schemes are part of the UK's strategy to meet the requirements of the Water Framework Directive. Schemes fall into 2 basic categories: Remedial – mitigating the impact of existing pollution or Preventative – preventing a future pollution incident.

Mine water treatment schemes generally consist of one or more primary settlement lagoons and one or more reed beds for secondary treatment. A small number are more specialised process treatment plants.

Future underground mining

Details of all planned underground mining relative to the enquiry boundary. Only those future workings where the enquiry boundary is within 0.7 times the depth of the workings (zone of likely physical influence) allowing for seam inclination will be included.

Coal mining licensing

Details of all licenses issued by the Coal Authority either within or within 200 metres of the enquiry boundary in relation to the under taking of surface coal mining, underground coal mining or underground coal gasification.

Court orders

Orders in respect of the working of coal under the Mines (Working Facilities and Support) Acts of 1923 and 1966 or any statutory modification or amendment thereof.

Section 46 notices

Notice of proposals relating to underground coal mining operations that have been given under section 46 of the Coal Mining Subsidence Act 1991.

Withdrawal of support notices

Published notices of entitlement to withdraw support and the date of the notice. Details of any revocation notice withdrawing the entitlement to withdraw support given under Section 41 of the Coal Industry Act 1994.

Payment to owners of former copyhold land

Relevant notices which may affect the property and any subsequent notice of retained interests in coal and coal mines, acceptance or rejection notices and whether any compensation has been paid to a claimant.

0345 762 6848 (UK)
+44 (0)1623 637 000 (International)
www.groundstability.com

APPENDIX D – EXPLORATORY HOLE RECORDS

Project Name: Wynnstay Technology Park,
Ruabon-Additional Testing

Client: Castlemead Group Ltd

Date: 13/02/2024

Location:

Contractor:

Co-ords: E329181.75 N343509.00

Project No. : 3060

Crew Name:

Equipment: Hand tools.

Location Number 24-HP01	Location Type TP	Level 127.00m AoD	Logged By AR	Scale 1:10	Page Number Sheet 1 of 1
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Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50	ES		0.50	126.50		Loose dark grey fine to coarse sub angular GRAVEL of clinker, red brick and mudstone with ash. (MADE GROUND)	
								End of Borehole at 0.500m	
									1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.40	0.40						

Remarks	GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH
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HP1 – 0.50m bgl

Project Name: Wynnstay Technology Park,
Ruabon-Additional Testing

Client: Castlemead Group Ltd

Date: 13/02/2024

Location:

Contractor:

Co-ords: E329165.97 N343550.00

Project No. : 3060

Crew Name:

Equipment: Hand tools.

Location Number 24-HP02	Location Type TP	Level 127.00m AoD	Logged By AR	Scale 1:10	Page Number Sheet 1 of 1
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Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.60	ES		0.60	126.40		Loose dark grey fine to coarse sub angular GRAVEL of clinker and mudstone with ash. (MADE GROUND)	
								End of Borehole at 0.600m	
									1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.40	0.40						

Remarks	GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH
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Project Name: Wynnstay Technology Park, Ruabon-Additional Testing		Client: Castlemead Group Ltd		Date: 13/02/2024	
Location:		Contractor:		Co-ords: E329158.73 N343582.00	
Project No. : 3060		Crew Name:		Equipment: Hand tools.	
Location Number 24-HP03	Location Type TP	Level 127.00m AoD	Logged By AR	Scale 1:10	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.70	ES		0.70	126.30		Loose dark grey fine to coarse sub angular GRAVEL of clinker and mudstone with ash. (MADE GROUND)	
								End of Borehole at 0.700m	
									1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.40	0.40						

Remarks						GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH	
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HP3 – 0.70m bgl

Project Name: Wynnstay Technology Park,
Ruabon-Additional Testing

Client: Castlemead Group Ltd

Date: 13/02/2024

Location:

Contractor:

Co-ords: E329151.50 N343604.00

Project No. : 3060

Crew Name:

Equipment: Hand tools.

Location Number 24-HP04	Location Type TP	Level 127.00m AoD	Logged By AR	Scale 1:10	Page Number Sheet 1 of 1
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Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.50	ES		0.50	126.50		Loose orange brown fine to coarse sub angular GRAVEL of clinker and mudstone with ash. (MADE GROUND)	
								End of Borehole at 0.500m	
									1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.40	0.40						

Remarks	GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH
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HP4 – 0.50m bgl

Page Number
Sheet 1 of 12

Remarks	GroundSolve Ltd Unit 1 Well House Barn Chester Road Bretton CH4 0DH
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HP5 – 0.35m bgl

Project Name: Wynnstay Technology Park, Ruabon-Additional Testing			Client: Castlemead Group Ltd		Date: 13/02/2024	
Location:			Contractor:		Co-ords: E329184.02 N343639.55	
Project No. : 3060			Crew Name:		Equipment: Hand tool	
Location Number 24-HP06		Location Type TP		Level 129.00m AoD	Logged By AR	Scale 1:10
					Page Number Sheet 1 of 1	

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.80	ES		0.80	128.20		Loose light reddish cream slightly sandy fine to coarse sub angular GRAVEL of mudstone with occasional cobbles. (MADE GROUND)	
								End of Borehole at 0.800m	1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.40	0.40						

Remarks						GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH	
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HP6 – 0.80m bgl

Project Name: Wynnstay Technology Park, Ruabon-Additional Testing		Client: Castlemead Group Ltd		Date: 13/02/2024	
Location:		Contractor:		Co-ords: E329214.17 N343641.82	
Project No. : 3060		Crew Name:		Equipment: Hand tools.	
Location Number 24-HP07	Location Type TP	Level 129.50m AoD	Logged By AR	Scale 1:10	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.80	ES		0.80	128.70		Loose light reddish cream slightly sandy fine to coarse sub angular GRAVEL of mudstone with occasional cobbles. (MADE GROUND)	
								End of Borehole at 0.800m	1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.40	0.40						

Remarks						GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH	
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Project Name: Wynnstay Technology Park, Ruabon-Additional Testing			Client: Castlemead Group Ltd		Date: 13/02/2024	
Location:			Contractor:		Co-ords: E329235.00 N343642.88	
Project No. : 3060			Crew Name:		Equipment: Hand tools.	
Location Number 24-HP08	Location Type TP		Level 130.00m AoD	Logged By AR	Scale 1:10	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.35	ES		0.80	129.20		Loose dark grey fine to coarse sub angular GRAVEL of clinker and mudstone with ash. (MADE GROUND)	
								End of Borehole at 0.800m	1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length 0.40	Pit Width 0.40	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks						GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH	
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HP8 – 0.35m bgl

Project Name: Wynnstay Technology Park, Ruabon-Additional Testing		Client: Castlemead Group Ltd		Date: 13/02/2024	
Location:		Contractor:		Co-ords: E329208.95 N343520.98	
Project No. : 3060		Crew Name:		Equipment:	
Location Number 24-HP09	Location Type TP	Level 123.69m AoD	Logged By	Scale 1:10	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.45	ES		0.45	123.24		Loose light reddish cream slightly sandy fine to coarse sub angular GRAVEL of mudstone, redbrick, clinker with ash with occasional cobbles. (MADE GROUND)	
								End of Borehole at 0.450m	
									1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks

Remarks	GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH
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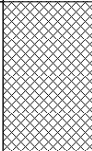
HP9 – 0.45m bgl

Project Name: Wynnstay Technology Park, Ruabon-Additional Testing		Client: Castlemead Group Ltd		Date: 13/02/2024	
Location:		Contractor:		Co-ords: E329264.91 N343536.95	
Project No. : 3060		Crew Name:		Equipment: Hand tools.	
Location Number 24-HP10	Location Type TP	Level 124.50m AoD	Logged By AR	Scale 1:10	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.10	ES		0.10	124.40		Loose light reddish cream slightly sandy fine to coarse sub angular GRAVEL of mudstone with occasional cobbles. (MADE GROUND) End of Borehole at 0.100m	1
									2

Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.40	0.40						

Remarks	GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH
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			Hand Dug Trial Pit					24-HP11			
Project Name: Wynnstay Technology Park, Ruabon-Additional Testing				Client: Castlemead Group Ltd				Date: 13/02/2024			
Location:				Contractor:				Co-ords: E329183.96 N343588.01			
Project No. : 3060				Crew Name:				Equipment: Hand tools.			
Location Number 24-HP11		Location Type TP		Level 124.65m AoD		Logged By AR		Scale 1:10		Page Number Sheet 1 of 1	
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results							
		0.10	ES		0.20	124.45		Loose light reddish cream slightly sandy fine to coarse sub angular GRAVEL of mudstone with occasional cobbles. (MADE GROUND)			1
		End of Borehole at 0.200m									
2											
Dimensions				Trench Support and Comment				Pumping Data			
Pit Length 0.40		Pit Width 0.40		Pit Stability	Shoring Used	Remarks			Date	Rate	Remarks
Remarks										GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH	



HP11 – 0.10m bgl

Project Name: Wynnstay Technology Park, Ruabon-Additional Testing				Client: Castlemead Group Ltd				Date: 13/02/2024			
Location:				Contractor:				Co-ords: E329251.86 N343578.24			
Project No. : 3060				Crew Name:				Equipment: Hand tools.			
Location Number 24-HP12		Location Type TP		Level 124.95m AoD		Logged By AR		Scale 1:10		Page Number Sheet 1 of 1	
Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description			
		Depth (m)	Type	Results				Loose dark grey fine to coarse sub angular GRAVEL of clinker and mudstone with ash. (MADE GROUND)			
		0.15	ES		0.15	124.80		End of Borehole at 0.150m			
1											
2											
Dimensions				Trench Support and Comment				Pumping Data			
Pit Length 0.40		Pit Width 0.40		Pit Stability	Shoring Used	Remarks		Date	Rate	Remarks	
Remarks										GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH	



HP12 – 0.15m bgl

Project Name: Wynnstay Technology Park, Ruabon-Additional Testing		Client: Castlemead Group Ltd		Date: 13/02/2024	
Location:		Contractor:		Co-ords: E329213.34 N343620.80	
Project No. : 3060		Crew Name:		Equipment: Hand tools.	
Location Number 24-HP13	Location Type TP	Level 125.70m AoD	Logged By AR	Scale 1:10	Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.40	ES		0.40	125.30		Loose light reddish cream slightly sandy fine to coarse sub angular GRAVEL of mudstone with occasional cobbles. (MADE GROUND)	
								End of Borehole at 0.400m	
									1
									2

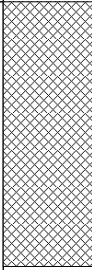
Dimensions		Trench Support and Comment			Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks	Date	Rate	Remarks
0.40	0.40						

Remarks	GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH
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HP13 – 0.40m bgl

Project Name: Wynnstay Technology Park, Ruabon-Additional Testing			Client: Castlemead Group Ltd			Date: 13/02/2024		
Location:			Contractor:			Co-ords: E329213.82 N343601.91		
Project No. : 3060			Crew Name:			Equipment: Hand tools.		
Location Number 24-HP14		Location Type TP		Level 125.30m AoD		Logged By AR		Scale 1:10 Page Number Sheet 1 of 1

Well	Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.35	ES		0.35	124.95		Loose light reddish cream slightly sandy fine to coarse sub angular GRAVEL of mudstone with occasional cobbles. (MADE GROUND)	1
								End of Borehole at 0.350m	
									2

Dimensions		Trench Support and Comment				Pumping Data		
Pit Length	Pit Width	Pit Stability	Shoring Used	Remarks		Date	Rate	Remarks
0.40	0.40							

Remarks							GroundSolve Ltd Unit 1 Well House Barns Chester Road Bretton CH4 0DH
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HP14 – 0.35m bgl

2 -



HP15 – 0.20m bgl

APPENDIX E – GAS MONITORING RECORDS

No: 3060

GROUNDWATER AND GROUND GAS MONITORING



Site: Ruabon Business Park

Location	Date	Monitored by	Well Details		Groundwater		Gas												Weather	
			Standpipe diameter (mm)	Depth to Base (m bgl)	Water Depth (m bgl)	Reduced Level (m OD)	Atmospheric Pressure (mbar)	Atmospheric Pressure Comment	Relative Pressure (mb)	Flow - Peak (l/h)	Flow - Steady (l/h)	CH ₄ (% v/v)	GSV CH ₄ (l/hr)	CO ₂ (% v/v)	GSV CO ₂ (l/hr)	O ₂ (% v/v)	CO (ppm)	H ₂ S (ppm)	Serial No.	Conditions
WS01	27/07/23	RP	50	1.50	Dry		1002	Falling	0.01	0.1	0.1	0.3	0.0003	3.2	0.0032	19.1	0.0	0.0		
	09/08/23	RP	50	1.50	Dry		998	Rising	0.10	0.1	0.1	0.2	0.0002	3.1	0.0031	19.5	0.0	0.0		
	22/08/23	RP	50	1.50	Dry		1005	Rising	0.10	0.1	0.1	0.3	0.0003	3.6	0.0036	19.4	0.0	0.0		
	07/09/23	RP	50	1.50	Dry		1000	Rising	0.10	0.1	0.1	0.2	0.0002	3.1	0.0031	19.2	0.0	0.0		
																				Monitoring well destroyed
																				Monitoring well destroyed
WS02	27/07/23	RP	50	1.00	Dry		1002	Falling	0.10	0.1	0.1	0.1	0.0001	2.5	0.0025	17.6	0.0	0.0		
	09/08/23	RP	50	1.00	Dry		998	Rising	0.01	0.1	0.1	0.1	0.0001	2.1	0.0021	17.1	0.0	0.0		
	22/08/23	RP	50	1.00	Dry		1005	Rising	0.10	0.1	0.1	0.1	0.0001	2.4	0.0024	16.8	0.0	0.0		
	07/09/23	RP	50	1.00	Dry		1000	Rising	0.01	0.0	0.1	0.1	0.0001	2.4	0.0024	17.3	0.0	0.0		
																				Monitoring well destroyed
																				Monitoring well destroyed
WS03	27/07/23	RP	50	2.00	1.80		1002	Falling	0.01	0.1	0.1	0.1	0.0001	1.9	0.0019	17.3	0.0	0.0		
	09/08/23	RP	50	2.00	1.97		998	Rising	0.01	0.1	0.1	0.1	0.0001	1.9	0.0019	17.5	0.0	0.0		
	22/08/23	RP	50	1.98	1.82		1005	Rising	0.01	0.1	0.1	0.1	0.0001	1.4	0.0014	17.1	0.0	0.0		
	07/09/23	RP	50	1.98	1.83		1000	Rising	0.01	0.1	0.1	0.1	0.0001	1.6	0.0016	17.3	0.0	0.0		
	20/02/24	AR	50	1.98	1.83		1007	Static	0.01	0.1	0.1	0.1	0.0001	1.0	0.0010	17.5	0.0	0.0		
	23/02/24	AB	50	1.98	1.83		967	Falling	0.01	0.1	0.1	0.1	0.0001	1.2	0.0012	17.3	0.0	0.0		
WS04	27/07/23	RP	50	1.00	Dry		1002	Falling	0.01	0.1	0.1	0.1	0.0001	2.1	0.0021	16.1	0.0	0.0		
	09/08/23	RP	50	1.00	Dry		998	Rising	0.10	0.1	0.1	0.2	0.0002	1.8	0.0018	15.7	0.0	0.0		
	22/08/23	RP	50	1.00	Dry		1005	Rising	0.01	0.1	0.1	0.2	0.0002	2.3	0.0023	16.9	0.0	0.0		
	07/09/23	RP	50	1.00	Dry		1000	Rising	0.10	0.1	0.1	0.2	0.0002	2.2	0.0022	15.9	0.0	0.0		
	20/02/24	AR	50	2.80	0.98		1007	Static	0.02	0.1	0.1	0.2	0.0002	2.1	0.0021	12.9	0.0	0.0		
	23/02/24	AB	50	2.80	1.00		963	Falling	0.01	0.0	0.1	0.1	0.0001	0.3	0.0003	16.0	0.0	0.0		
WS05	27/07/23	RP	50	3.00	2.93		1002	Falling	0.01	0.1	0.1	0.2	0.0002	2.0	0.0020	18.4	0.0	0.0		
	09/08/23	RP	50	2.95	2.75		998	Rising	0.01	0.1	0.1	0.2	0.0002	2.1	0.0021	18.0	0.0	0.0		
	22/08/23	RP	50	2.94	2.91		1005	Rising	0.10	0.1	0.1	0.2	0.0002	1.6	0.0016	18.3	0.0	0.0		
	07/09/23	RP	50	2.94	2.88		1000	Rising	0.10	0.1	0.1	0.2	0.0002	1.8	0.0018	18.0	0.0	0.0		
	20/02/24	AR	50	1.35	-		1007	Static	-0.02	0.1	0.1	0.1	0.0001	0.8	0.0008	20.8	0.0	0.0		
	23/02/24	AB	50	1.35	1.35		967	Falling	0.01	0.1	0.1	0.1	0.0001	0.7	0.0007	15.9	0.0	0.0		

NOTES:

NM = Not Measured.

(x) = Peak value recorded.

[grey] = Below detection limit.

$$\text{GSV (l/HR)} = [\text{gas concentration (\%v/v)}] \times [\text{gas well flow rate (l/hr)}]$$

100

APPENDIX F – CHEMICAL TEST RESULTS

Job No: 3060

Site Location: Wynnstey Technology Park Ruabon

Residential with gardens (1% SOM)



	20-TP02	20-TP04	20-TP06	20-TP10	20-WS02	20-WS04	20-TP01	20-TP01	20-TP02	20-TP05	20-TP07	20-TP08	24-HP09	24-HP10	24-HP11	24-HP12	24-HP13	24-HP14	24-HP15								
Metals & Non-Metals	2.10	0.50	1.00	0.50	3.50	2.00	2.00	0.50	0.50	0.50	0.50	0.50	0.45	0.10	0.10	0.15	0.40	0.35	0.20	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedance s	
Arsenic	-	16	2.8	14	-	-	-	9	57	10	15	20	10.9	13.1	12.8	42.8	29.4	19.7	7	-	57	18.63	15	37	C4SL	2	
Boron, water soluble	-	0.4	0.5	0.5	-	-	-	0.3	0.8	0.5	0.7	0.5	-	-	-	-	-	-	-	-	0.8	0.53	8	290	S4UL	0	
Cadmium	-	0.3	< 0.1	0.5	-	-	-	0.3	< 0.1	0.3	0.7	0.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	0.7	0.41	15	22	C4SL	0	
Chromium III	-	15	16	10	-	-	-	15	29	11	15	17	13.9	18.8	14.9	21.2	23.8	12.8	12.5	-	29	16.39	15	910	S4UL	0	
Chromium, Hexavalent	-	< 1.0	< 1.0	< 1.0	-	-	-	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	-	-	-	-	-	-	-	-	< 1	1	8	21	C4SL	0	
Copper	-	45	24	31	-	-	-	27	60	49	43	53	41.8	59.7	38.3	55.7	69.9	59.7	37.3	-	69.9	46.29	15	2400	S4UL	0	
Lead	-	49	15	30	-	-	-	72	68	24	69	36	21	81.4	59.2	120	85	45.3	24.2	-	120	53.27	15	200	S4UL	0	
Mercury	-	0.1	< 0.05	< 0.05	-	-	-	< 0.05	< 0.05	< 0.05	0.12	0.18	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.28	15	1.2	S4UL	0	
Nickel	-	32	56	62	-	-	-	27	37	30	31	33	32.7	22.7	25.2	44.2	69.9	50.7	35.7	-	69.9	39.27	15	130	S4UL	0	
Phenol - Monohydric	-	1.7	< 0.3	< 0.3	-	-	-	< 0.3	< 0.3	< 0.3	0.4	0.3	< 5	< 5	< 5	< 5	< 5	< 5	< 5	-	< 5	2.59	15	120	S4UL	0	
Selenium	-	2.2	< 0.5	3.3	-	-	-	< 0.5	< 0.5	1.6	1	1.6	< 1.0	< 1.0	< 1.0	1.4	2.3	1.9	< 1.0	-	3.3	1.39	15	250	S4UL	0	
Zinc	-	91	59	92	-	-	-	79	71	83	220	91	51.2	81.4	63.9	69.6	71.7	77.5	56.6	-	220	83.86	15	3700	S4UL	0	

	20-TP02	20-TP04	20-TP06	20-TP10	20-WS02	20-WS04	20-TP01	20-TP01	20-TP02	20-TP05	20-TP07	20-TP08	24-HP09	24-HP10	24-HP11	24-HP12	24-HP13	24-HP14	24-HP15								
Petroleum Hydrocarbons	2.10	0.50	1.00	0.50	3.50	2.00	2.00	0.50	0.50	0.50	0.50	0.50	0.45	0.10	0.10	0.15	0.40	0.35	0.20	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedance s	
Aliphatic C5-C6	-	< 0.01	< 0.01	< 0.01	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-	-	-	< 0.01	0.01	8	42	S4UL	0	
Aliphatic C6-C8	-	< 0.01	< 0.01	< 0.01	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-	-	-	< 0.01	0.01	8	100	S4UL	0	
Aliphatic C8-C10	-	< 0.01	< 0.01	< 0.01	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-	-	-	< 0.01	0.01	8	27	S4UL	0	
Aliphatic C10-C12	-	< 1.5	< 1.5	< 1.5	-	-	-	< 1.5	< 1.5	< 1.5	< 1.5	< 1.5	-	-	-	-	-	-	-	-	< 1.5	1.5	8	130	S4UL	0	
Aliphatic C12-C16	-	< 1.2	< 1.2	< 1.2	-	-	-	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	-	-	-	-	-	-	-	-	< 1.2	1.2	8	1100	S4UL	0	
Aliphatic C16-C35	-	< 3.4	< 3.4	< 3.4	-	-	-	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	-	-	-	-	-	-	-	-	< 3.4	3.4	8	65000	S4UL	0	
Aliphatic C35-C40	-	< 3.4	< 3.4	< 3.4	-	-	-	< 3.4	< 3.4	< 3.4	< 3.4	< 3.4	-	-	-	-	-	-	-	-	< 3.4	3.4	8	65000	S4UL	0	
Aromatic C5-C7	-	< 0.01	< 0.01	< 0.01	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-	-	-	< 0.01	0.01	8	70	S4UL	0	
Aromatic C7-C8	-	< 0.01	< 0.01	< 0.01	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-	-	-	< 0.01	0.01	8	130	S4UL	0	
Aromatic C8-C10	-	< 0.01	< 0.01	< 0.01	-	-	-	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	-	-	-	-	-	-	-	-	< 0.01	0.01	8	34	S4UL	0	
Aromatic C10-C12	-	< 0.9	< 0.9	< 0.9	-	-	-	< 0.9	< 0.9	< 0.9	< 0.9	< 0.9	-	-	-	-	-	-	-	-	< 0.9	0.9	8	74	S4UL	0	
Aromatic C12-C16	-	< 0.5	< 0.5	< 0.5	-	-	-	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	-	-	-	-	-	-	-	< 0.5	0.5	8	140	S4UL	0	
Aromatic C16-C21	-	< 0.6	< 0.6	< 0.6	-	-	-	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	-	-	-	-	-	-	-	-	< 0.6	0.6	8	260	S4UL	0	
Aromatic C21-C35	-	< 1.4	< 1.4	< 1.4	-	-	-	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	-	-	-	-	-	-	-	-	< 1.4	1.4	8	1100	S4UL	0	
Aromatic C35-C40	-	< 1.4	< 1.4	< 1.4	-	-	-	< 1.4	< 1.4	< 1.4	< 1.4	< 1.4	-	-	-	-	-	-	-	-	< 1.4	1.4	8	1100	S4UL	0	

	20-TP02	20-TP04	20-TP06	20-TP10	20-WS02	20-WS04	20-TP01	20-TP01	20-TP02	20-TP05	20-TP07	20-TP08	24-HP09	24-HP10	24-HP11	24-HP12	24-HP13	24-HP14	24-HP15								
Polyaromatic Hydrocarbons (PAH)	2.10	0.50	1.00	0.50	3.50	2.00	2.00	0.50	0.50	0.50	0.50	0.50	0.45	0.10	0.10	0.15	0.40	0.35	0.20	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedance s	
Acenaphthene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.25	15	210	S4UL	0	
Acenaphthylene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.25	15	170	S4UL	0	
Anthracene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.09	0.04	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.25	15	2400	S4UL	0	
Benzo(a)anthracene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.34	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.27	15	7.2	S4UL	0	
Benzo(a)pyrene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.27	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.27	15	5	C4SL	0	
Benzo(b)fluoranthene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.35	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.27	15	2.6	S4UL	0	
Benzo(g,h,i)perylene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.13	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.26	15	320	S4UL	0	
Benzo(k)fluoranthene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.14	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.26	15	77	S4UL	0	
Chrysene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.39	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.27	15	15	S4UL	0	
Dibenz(a,h)anthracene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.25	15	0.24	S4UL	0	
Fluoranthene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	1.1	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	1.1	0.32	15	280	S4UL	0	
Fluorene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.25	15	170	S4UL	0	
Indeno(1,2,3-c,d)pyrene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.12	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.26	15	27	S4UL	0	
Naphthalene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.05	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.25	15	2.3	S4UL	0	
Phenanthrene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.44	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	< 0.5	0.28	15	95	S4UL	0	
Pyrene	-	< 0.03	< 0.03	< 0.03	-	-	-	< 0.03	< 0.03	< 0.03	0.96	< 0.03	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	-	0.96	0.31	15	620	S4UL	0	

	20-TP02	20-TP04	20-TP06	20-TP10	20-WS02	20-WS04	20-TP01	20-TP01	20-TP02	20-TP05	20-TP07	20-TP08	24-HP09	24-HP10	24-HP11	24-HP12	24-HP13	24-HP14	24-HP15								
Other Contaminants / Testing	2.10	0.50	1.00	0.50	3.50	2.00	2.00	0.50	0.50	0.50	0.50	0.50	0.45	0.10	0.10	0.15	0.40	0.35	0.20	Min (mg/kg)	Max (mg/kg)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedance s	
	-	1.8	2	0.6	-	-	-	0.8	0.6	5.7	7.4	5.1	1.1	5.3	4.9	5.4	12	7.4	1	-	12	4.07	15	-	-	-	
	7.8	6.7	7.6	7.6	7.7	7.6	5.4	8	6.6	6.3	7	7.1	7.4	7.7	7.1	7	4.9	6	6.8	4.9	8	6.96	19	-	-	-	
	24	52	< 10	< 10	-	-	-	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	60	8	24	-	-	-	
	-	0.1	< 0.1	< 0.1	-	-	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	0.52	15	-	-	-	
	-	13	5	< 0.75	-	-	-	< 0.75	< 0.75	< 0.75	5.3	1.9	-	-	-	-	-	-	-	-	13	3.53	8	-	-	-	
	-	1700	89	110	110	94	100	110	55	17	15	30	18	< 20	< 20	< 20	< 20	120	< 20	< 20	< 20	1700	141.47	19	-	-	-

Job No: 3060

Site Location: Wynnstey Technology Park, Ruabon

POS(resi) (1% SOM)



	HP01	HP02	HP03	HP04	HP05	HP06	HP07	HP08								
	0.50	0.60	0.70	0.50	0.35	0.80	0.80	0.35	Min (mg/kg)	Max (mg/kg)	Average (Unround)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Metals & Non-Metals																
Arsenic	22.9	31.4	15.1	18.7	38.3	23.1	41.3	19.8	15.1	41.3	26.33	26.33	8	79	C4SL	0
Cadmium	0.6	<0.5	0.8	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	0.8	0.56	0.56	8	220	C4SL	0
Copper	71.2	72.2	68.1	53.1	36.4	63.7	31.7	60.1	31.7	72.2	57.06	57.06	8	12000	S4UL	0
Lead	74.4	61	70.9	51.1	118	54	69.9	48.4	48.4	118	68.46	68.46	8	630	C4SL	0
Mercury	<0.5	<0.5	1.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.9	0.68	0.68	8	16	S4UL	0
Nickel	34	35.5	36.4	42.1	25.6	44.6	35	34.2	25.6	44.6	35.93	35.93	8	230	S4UL	0
Phenol - Monohydric	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5.00	5	8	440	S4UL	0
Selenium	1.5	2.3	4.6	3.4	2.1	2.3	1.8	1.9	1.5	4.6	2.49	2.49	8	1100	S4UL	0
Zinc	162	95.8	88.7	82.6	41.3	59	48.8	77.9	41.3	162	82.01	82.01	8	81000	S4UL	0

	HP01	HP02	HP03	HP04	HP05	HP06	HP07	HP08								
	0.50	0.60	0.70	0.50	0.35	0.80	0.80	0.35	Min (mg/kg)	Max (mg/kg)	Average (Unround)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Petroleum Hydrocarbons																
Benzene	-	<0.01	-	-	<0.01	-	<0.01	-	< 0.01	<0.01	0.01	0.01	3	140	C4SL	0
Toluene	-	<0.01	-	-	<0.01	-	<0.01	-	< 0.01	<0.01	0.01	0.01	3	56000	S4UL	0
Ethylbenzene	-	<0.01	-	-	<0.01	-	<0.01	-	< 0.01	<0.01	0.01	0.01	3	24000	S4UL	0
xylene	-	<0.01	-	-	<0.01	-	<0.01	-	< 0.01	<0.01	0.01	0.01	3	-	S4UL	3
Aliphatic C5-C6	-	<0.01	-	-	<0.01	-	<0.01	-	< 0.01	<0.01	0.01	0.01	3	570000	S4UL	0
Aliphatic C6-C8	-	<0.01	-	-	<0.01	-	<0.01	-	< 0.01	<0.01	0.01	0.01	3	600000	S4UL	0
Aliphatic C8-C10	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	13000	S4UL	0
Aliphatic >EC10-EC12	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	13000	S4UL	0
Aliphatic >EC12-EC16	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	13000	S4UL	0
Aliphatic >EC16-EC35	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	250000	S4UL	0
Aliphatic >EC35-EC40	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	250000	S4UL	0
Aromatic C5-C7	-	<0.01	-	-	<0.01	-	<0.01	-	< 0.01	<0.01	0.01	0.01	3	56000	S4UL	0
Aromatic C7-C8	-	<0.01	-	-	<0.01	-	<0.01	-	< 0.01	<0.01	0.01	0.01	3	56000	S4UL	0
Aromatic C8-C10	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	5000	S4UL	0
Aromatic >EC10-EC12	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	5000	S4UL	0
Aromatic >EC12-EC16	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	5100	S4UL	0
Aromatic >EC16-EC21	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	3800	S4UL	0
Aromatic >EC21-EC35	-	1.5	-	-	<1.0	-	<1.0	-	< 1.0	1.5	1.17	1.17	3	3800	S4UL	0
Aromatic >EC35-EC40	-	<1.0	-	-	<1.0	-	<1.0	-	< 1.0	<1	1.00	1	3	3800	S4UL	0

	HP01	HP02	HP03	HP04	HP05	HP06	HP07	HP08								
	0.50	0.60	0.70	0.50	0.35	0.80	0.80	0.35	Min (mg/kg)	Max (mg/kg)	Average (Unround)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Polyaromatic Hydrocarbons (PAH)																
Acenaphthene	<0.5	1.5	1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1.5	0.69	0.69	8	15000	S4UL	0
Acenaphthylene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	15000	S4UL	0
Anthracene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	74000	S4UL	0
Benzo(a)anthracene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	29	S4UL	0
Benzo(a)pyrene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	10	C4SL	0
Benzo(b)fluoranthene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	7.1	S4UL	0
Benzo(g,h,i)perylene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	640	S4UL	0
Benzo(k)fluoranthene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	190	S4UL	0
Chrysene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	57	S4UL	0
Dibenzo(a,h)anthracene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	0.57	S4UL	0
Fluoranthene	<0.5	<0.5	0.9	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	0.55	0.55	8	3100	S4UL	0
Fluorene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	9900	S4UL	0
Indeno(1,2,3-c,d)pyrene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	82	S4UL	0
Naphthalene	<0.5	4.2	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	4.2	0.98	0.98	8	4900	S4UL	0
Phenanthrene	<0.5	5.3	9.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	9.6	2.24	2.24	8	3100	S4UL	0
Pyrene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.50	0.5	8	7400	S4UL	0

	HP01	HP02	HP03	HP04	HP05	HP06	HP07	HP08								
	0.50	0.60	0.70	0.50	0.35	0.80	0.80	0.35	Min (mg/kg)	Max (mg/kg)	Average (Unround)	Average (mg/kg)	Count	Adopted Guideline (mg/kg)	Source	Exceedances
Other Contaminants / Testing																
Organic Matter	2.5	5.6	7.5	1.6	0.4	4.9	1	7.1	0.4	7.5	3.83	3.83	8	-	-	-
pH	8.2	7.2	6.1	6.7	7	6.1	6.9	6.5	6.1	8.2	6.84	6.84	8	-	-	-
Cyanide, Total	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1	1.00	1	8	-	-	-
Sulphate Aqueous Extract as SO4	110	30	20	<20	20	30	<20	<20	<20	110	33.75	33.75	8	-	-	-



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Certificate of Analysis

THE ENVIRONMENTAL LABORATORY LTD

Analytical Report Number: 24-52394

Issue: 1

Date of Issue: 22/02/2024

Contact: Alex Ridge

Customer Details: GroundSolve Ltd
Unit 1 Well House Barns
Chester Road
Bretton
FlintshireCH4 0DH

Quotation No: Q24-04319

Order No: Not Supplied

Customer Reference: 3060

Date Received: 16/02/2024

Date Approved: 22/02/2024

Details: Wynnstay Technology Park

Approved by:

Ben Rees, Customer Services Assistant



Sample Summary

Report No.: 24-52394, issue number 1

Elab No.	Client's Ref.	Date Sampled	Date Scheduled	Description	Deviations
353077	HP01 0.50	13/02/2024	16/02/2024	Sandy silty loam	
353078	HP02 0.60	13/02/2024	16/02/2024	Sandy silty loam	
353079	HP03 0.70	13/02/2024	16/02/2024	Silty loam	
353080	HP04 0.50	13/02/2024	16/02/2024	Silty loam	
353081	HP05 0.35	13/02/2024	16/02/2024	Sandy silty loam	
353082	HP06 0.80	13/02/2024	16/02/2024	Sandy silty loam	
353083	HP07 0.80	13/02/2024	16/02/2024	Silty loam	
353084	HP08 0.35	13/02/2024	16/02/2024	Sandy silty loam	
353085	HP09 0.45	13/02/2024	16/02/2024	Silty loam	
353086	HP10 0.10	13/02/2024	16/02/2024	Silty loam	
353087	HP11 0.10	13/02/2024	16/02/2024	Silty loam	
353088	HP12 0.15	13/02/2024	16/02/2024	Sandy silty loam	
353089	HP13 0.40	13/02/2024	16/02/2024	Silty loam	
353090	HP14 0.35	13/02/2024	16/02/2024	Sandy silty loam	
353091	HP15 0.20	13/02/2024	16/02/2024	Silty loam	



Results Summary

Report No.: 24-52394, issue number 1

				ELAB Reference	353077	353078	353079	353080	353081	353082	353083	353084	353085	353086	353087	353088	353089	353090	353091
				Customer Reference															
				Sample ID															
				Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
				Sample Location	HP01	HP02	HP03	HP04	HP05	HP06	HP07	HP08	HP09	HP10	HP11	HP12	HP13	HP14	HP15
				Sample Depth (m)	0.50	0.60	0.70	0.50	0.35	0.80	0.80	0.35	0.45	0.10	0.10	0.15	0.40	0.35	0.20
				Sampling Date	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024
Determinand		Codes	Units	LOD															
Soil sample preparation parameters																			
Moisture Content		N	%	0.1	9.8	10.9	14.3	14.4	12.4	10.5	12.2	11.3	10.9	16.7	17.4	10.6	11.4	9.5	7.4
Stones Content		N	%	0.1	15.5	< 0.1	8.4	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	14.1	14.8	21.5	< 0.1	< 0.1	17.8
Material removed		N	%	0.1	15.5	< 0.1	8.4	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	14.1	14.8	21.5	< 0.1	< 0.1	17.8
Description of Inert material removed		N		0	Stones	None	Stones	None	None	None	None	None	None	Stones	Stones	Stones	None	None	Stones
Metals																			
Arsenic		M	mg/kg	1	22.9	31.4	15.1	18.7	38.3	23.1	41.3	19.8	10.9	13.1	12.8	42.8	29.4	19.7	7.0
Cadmium		M	mg/kg	0.5	0.6	< 0.5	0.8	0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Chromium		M	mg/kg	5	15.6	12.7	14.7	30.1	22.0	19.9	21.3	25.7	13.9	18.8	14.9	21.2	23.8	12.8	12.5
Copper		M	mg/kg	5	71.2	72.2	68.1	53.1	36.4	63.7	31.7	60.1	41.8	59.7	38.3	55.7	69.9	59.7	37.3
Lead		M	mg/kg	5	74.4	61.0	70.9	51.1	118	54.0	69.9	48.4	21.0	81.4	59.2	120	85.0	45.3	24.2
Mercury		M	mg/kg	0.5	< 0.5	< 0.5	1.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Nickel		M	mg/kg	5	34.0	35.5	36.4	42.1	25.6	44.6	35.0	34.2	32.7	22.7	25.2	44.2	69.9	50.7	35.7
Selenium		M	mg/kg	1	1.5	2.3	4.6	3.4	2.1	2.3	1.8	1.9	< 1.0	< 1.0	< 1.0	1.4	2.3	1.9	< 1.0
Zinc		M	mg/kg	5	162	95.8	88.7	82.6	41.3	59.0	48.8	77.9	51.2	81.4	63.9	69.6	71.7	77.5	56.6
Anions																			
Water Soluble Sulphate		M	g/l	0.02	0.11	0.03	0.02	< 0.02	0.02	0.03	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.12	< 0.02	< 0.02
Inorganics																			
Total Cyanide		M	mg/kg	1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Acid Soluble Sulphate (SO4)		U	%	0.02	n/t	0.36	n/t	n/t	1.19	n/t	1.00	n/t	n/t	n/t	n/t	n/t	n/t	n/t	n/t
Miscellaneous																			
pH		M	pH units	0.1	8.2	7.2	6.1	6.7	7.0	6.1	6.9	6.5	7.4	7.7	7.1	7.0	4.9	6.0	6.8
Soil Organic Matter		U	%	0.1	2.5	5.6	7.5	1.6	0.4	4.9	1.0	7.1	1.1	5.3	4.9	5.4	12	7.4	1.0
Total Organic Carbon		N	%	0.01	25	18	15	5.8	0.18	5.3	0.39	17	2.3	6.6	8.1	17	13	12	1.5



Results Summary

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Report No.: 24-52394, issue number 1

ELAB Reference				353077	353078	353079	353080	353081	353082	353083	353084	353085	353086	353087	353088	353089	353090	353091
Customer Reference																		
Sample ID																		
Sample Type				SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sample Location				HP01	HP02	HP03	HP04	HP05	HP06	HP07	HP08	HP09	HP10	HP11	HP12	HP13	HP14	HP15
Sample Depth (m)				0.50	0.60	0.70	0.50	0.35	0.80	0.80	0.35	0.45	0.10	0.10	0.15	0.40	0.35	0.20
Sampling Date				13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024
Determinand	Codes	Units	LOD															
Organics																		
>C8-C10 BCB (EH_1D_Total)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t	n/t	n/t	n/t
>C10-C12 BCB (EH_1D_Total)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t	n/t	n/t	n/t
>C12-C16 BCB (EH_1D_Total)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t	n/t	n/t	n/t
>C16-C21 BCB (EH_1D_Total)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t	n/t	n/t	n/t
Diesel Range Organics (>C8-C21) (EH_1D_Total)	N	mg/kg	1	n/t	< 1	n/t	n/t	< 1	n/t	< 1	n/t	n/t	n/t	n/t	n/t	n/t	n/t	n/t
Phenols																		
Total Monohydric Phenols	N	mg/kg	5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Polyaromatic hydrocarbons																		
Naphthalene	N	mg/kg	0.5	< 0.5	4.2	0.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthylene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Acenaphthene	N	mg/kg	0.5	< 0.5	1.5	1.0	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluorene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Phenanthrene	N	mg/kg	0.5	< 0.5	5.3	9.6	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Anthracene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Fluoranthene	N	mg/kg	0.5	< 0.5	< 0.5	0.9	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Pyrene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)anthracene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Chrysene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(b)fluoranthene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(k)fluoranthene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo(a)pyrene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Indeno(1,2,3-cd)pyrene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Dibenzo(a,h)anthracene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Benzo[g,h,i]perylene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Coronene	N	mg/kg	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Total PAH(16)	N	mg/kg	0.4	2.3	13.2	14.2	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	2.1	0.7	2.5	< 0.4	< 0.4	< 0.4	< 0.4



Results Summary

Report No.: 24-52394, issue number 1

ELAB Reference	353077	353078	353079	353080	353081	353082	353083	353084	353085	353086	353087	353088	353089	353090	353091
Customer Reference															
Sample ID															
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
Sample Location	HP01	HP02	HP03	HP04	HP05	HP06	HP07	HP08	HP09	HP10	HP11	HP12	HP13	HP14	HP15
Sample Depth (m)	0.50	0.60	0.70	0.50	0.35	0.80	0.80	0.35	0.45	0.10	0.10	0.15	0.40	0.35	0.20
Sampling Date	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024	13/02/2024
Determinand	Codes	Units	LOD												
BTEX															
Benzene	M	ug/kg	10	n/t	< 10.0	n/t	n/t	< 10.0	n/t	< 10.0	n/t	n/t	n/t	n/t	n/t
Toluene	M	ug/kg	10	n/t	< 10.0	n/t	n/t	< 10.0	n/t	< 10.0	n/t	n/t	n/t	n/t	n/t
Ethylbenzene	M	ug/kg	10	n/t	< 10.0	n/t	n/t	< 10.0	n/t	< 10.0	n/t	n/t	n/t	n/t	n/t
Xylenes	M	ug/kg	10	n/t	< 10.0	n/t	n/t	< 10.0	n/t	< 10.0	n/t	n/t	n/t	n/t	n/t
MTBE	U	ug/kg	10	n/t	< 10.0	n/t	n/t	< 10.0	n/t	< 10.0	n/t	n/t	n/t	n/t	n/t
TPH CWG															
>C5-C6 Aliphatic (HS_1D_MS_AL)	N	mg/kg	0.01	n/t	< 0.01	n/t	n/t	< 0.01	n/t	< 0.01	n/t	n/t	n/t	n/t	n/t
>C6-C8 Aliphatic (HS_1D_MS_AL)	N	mg/kg	0.01	n/t	< 0.01	n/t	n/t	< 0.01	n/t	< 0.01	n/t	n/t	n/t	n/t	n/t
>C8-C10 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C10-C12 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C12-C16 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C16-C21 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C16-C35 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C21-C35 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C35-C40 Aliphatic (EH_CU_1D_AL)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
Total (>C5-C40) Aliphatic (HS_1D_MS+EH_CU_1D_AL)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C5-C7 Aromatic (HS_1D_MS_AR)	N	mg/kg	0.01	n/t	< 0.01	n/t	n/t	< 0.01	n/t	< 0.01	n/t	n/t	n/t	n/t	n/t
>C7-C8 Aromatic (HS_1D_MS_AR)	N	mg/kg	0.01	n/t	< 0.01	n/t	n/t	< 0.01	n/t	< 0.01	n/t	n/t	n/t	n/t	n/t
>C8-C10 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C10-C12 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C12-C16 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C16-C21 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C21-C35 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	n/t	1.5	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
>C35-C40 Aromatic (EH_CU_1D_AR)	N	mg/kg	1	n/t	< 1.0	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
Total (>C5-C40) Aromatic (HS_1D_MS+EH_CU_1D_AR)	N	mg/kg	1	n/t	1.5	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
Total (>C5-C40) Ali/Aro (HS_1D_MS+EH_CU_1D_Total)	N	mg/kg	1	n/t	1.5	n/t	n/t	< 1.0	n/t	< 1.0	n/t	n/t	n/t	n/t	n/t
Total Petroleum Hydrocarbons															
Mineral Oil w Florisil (EH_CU_1D_Total)	N	mg/kg	5	n/t	6	n/t	n/t	< 5	n/t	< 5	n/t	n/t	n/t	n/t	n/t



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Results Summary

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Asbestos Results

Analytical result only applies to the sample as submitted by the client. Any comments, opinions or interpretations (marked #) in this report are outside UKAS accreditation (Accreditation No2683). They are subjective comments only which must be verified by the client.

In accordance with procedures, a 1kg soil sample should be analysed. For amounts less than this caution should be used when analysing the data as sample size is smaller than the recommended amount, therefore samples could be deemed as not being representative of the materials present on site.

Elab No	Depth (m)	Clients Reference	Description of Sample Matrix #	Asbestos Identification	Gravimetric Analysis Total (%)	Gravimetric Analysis by ACM Type (%)	Free Fibre Analysis (%)	Total Asbestos (%)	F/mm2 (l)
353077	0.50	HP01	Black Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353078	0.60	HP02	Dark Soil, Stones, Concrete, Clinker	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353079	0.70	HP03	Dark Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353080	0.50	HP04	Dark Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353081	0.35	HP05	Brown Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353082	0.80	HP06	Dark Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353083	0.80	HP07	Brown Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353084	0.35	HP08	Dark Sandy Soil, Stones, Clinker	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353085	0.45	HP09	Brown Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353086	0.10	HP10	Brown Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353087	0.10	HP11	Brown Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353088	0.15	HP12	Brown Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353089	0.40	HP13	Brown Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353090	0.35	HP14	Dark Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t
353091	0.20	HP15	Grey Sandy Soil, Stones	No asbestos detected	n/t	n/t	n/t	n/t	n/t

Method Summary

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Parameter	Codes	Analysis Undertaken On	Date Tested	Method Number	Technique
Soil					
pH	M	Air dried sample	19/02/2024	113	Electromeric
Acid Soluble Sulphate	U	Air dried sample	22/02/2024	115	Ion Chromatography
Aqua regia extractable metals	M	Air dried sample	19/02/2024	300	ICPMS
Phenols in solids	N	As submitted sample	19/02/2024	121	HPLC
PAH (GC-FID)	N	As submitted sample	19/02/2024	133	GC-FID
Water soluble anions	M	Air dried sample	19/02/2024	172	Ion Chromatography
Low range Aliphatic hydrocarbons soil	N	As submitted sample	21/02/2024	181	GC-MS
Low range Aromatic hydrocarbons soil	N	As submitted sample	21/02/2024	181	GC-MS
BTEX in solids	M	As submitted sample	21/02/2024	181A	GC-MS
Total cyanide	M	As submitted sample	20/02/2024	204	Colorimetry
Total organic carbon/Total sulphur	N	Air dried sample	20/02/2024	210	IR
Aliphatic hydrocarbons in soil	N	As submitted sample	21/02/2024	214	GC-FID
Aliphatic/Aromatic hydrocarbons in soil	N	As submitted sample	21/02/2024	214	GC-FID
Aromatic hydrocarbons in soil	N	As submitted sample	21/02/2024	214	GC-FID
Basic carbon banding in soil	N	As submitted sample	19/02/2024	218	GC-FID
Diesel range organics in soil	N	As submitted sample	20/02/2024	257	GC-FID
Asbestos identification	U	Air dried sample	22/02/2024	281	Microscopy
Soil organic matter	U	Air dried sample	19/02/2024	BS1377:P3	Titrimetry
TPH with Florisil clean up solids	N	As submitted sample	19/02/2024	GCL117	GC-FID

Tests marked N are not UKAS accredited

Report Information

Report No.: 24-52394, issue number 1

Key

U	hold UKAS accreditation
M	hold MCERTS and UKAS accreditation
N	do not currently hold UKAS accreditation
^	MCERTS accreditation not applicable for sample matrix
*	UKAS accreditation not applicable for sample matrix
S	Subcontracted to approved laboratory UKAS Accredited for the test
SM	Subcontracted to approved laboratory MCERTS/UKAS Accredited for the test
NS	Subcontracted to approved laboratory. UKAS accreditation is not applicable.
I/S	Insufficient Sample
U/S	Unsuitable sample
n/t	Not tested
<	means "less than"
>	means "greater than"
LOD	LOD refers to limit of detection, except in the case of pH soils and pH waters where it means limit of discrimination. Soil sample results are expressed on an air dried basis (dried at < 30°C), and are uncorrected for inert material removed. ELAB are unable to provide an interpretation or opinion on the content of this report. The results relate only to the sample received. PCB congener results may include any coeluting PCBs Uncertainty of measurement for the determinands tested are available upon request Unless otherwise stated, sample information has been provided by the client. This may affect the validity of the results.

Deviation Codes

- | | |
|---|--|
| a | No date of sampling supplied |
| b | No time of sampling supplied (Waters Only) |
| c | Sample not received in appropriate containers |
| d | Sample not received in cooled condition |
| e | The container has been incorrectly filled |
| f | Sample age exceeds stability time (sampling to receipt) |
| g | Sample age exceeds stability time (sampling to analysis) |

Where a sample has a deviation code, the applicable test result may be invalid.

Sample Retention and Disposal

All soil samples will be retained for a period of one month

All water samples will be retained for 7 days following the date of the test report

Charges may apply to extended sample storage

TPH Classification - HWOL Acronym System

HS	Headspace analysis
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent
CU	Clean-up - e.g. by florisil, silica gel
1D	GC - Single coil gas chromatography
Total	Aliphatics & Aromatics
AL	Aliphatics only
AR	Aromatics only
2D	GC-GC - Double coil gas chromatography
#1	EH_Total but with humics mathematically subtracted
#2	EH_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +)
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry

End of Report

APPENDIX G – CURRENT GUIDANCE FOR GROUND GAS RISK ASSESSMENT

Current Guidance for Ground Gas Risk Assessment

Origin of Ground and Landfill Gases

When carrying out a ground gas risk assessment for permanent ground gases (e.g., methane and carbon dioxide), the origin or source of the gases is important as potential risks will vary depending on the source. This Appendix relates to the risk of the two main ground gases of concern: methane and carbon dioxide and does not apply to other ground gases (e.g., radon or vapours from hydrocarbon spills). Methane and carbon dioxide are major constituents of landfill gas but can also occur from a variety of anthropogenic and natural sources, as summarised in Table G1 below:

Table G1. Potential Sources of Ground Gases		
Gas	Source	Comments
Landfill Gas	Anaerobic decomposition of degradable waste within landfill sites. Typically, 60% methane and 40% carbon dioxide during methanogenic phase.	Composition varies over time, particularly in early stages. Contains a range of minor constituents (particularly carbon monoxide and hydrogen sulphide).
Landfill Associated Gases	- Anaerobic degradation of leachate external to the site; - Degassing of dissolved gases in groundwater; - Evolution of gases following interaction between leachate and groundwater	Can result in secondary (external) production of methane or carbon dioxide.
Made Ground	Anaerobic degradation of organic components	Very variable depending on source
Sewer Gas, Cess Pits	Anaerobic degradation of organic components of sewage producing methane and carbon dioxide.	Often characterised by hydrogen sulphide odour.
Mains Gas	Leakage from underground pipework or storage tanks. Mainly methane but often contains higher alkanes.	An odouriser is added to permit detection of leaks. Typically, 90% CH ₄ , but 1 to 27% C ₂ -C ₄ alkanes, May also contain other trace gases e.g., CO, helium and CO ₂ (from degradation of CH ₄ in the ground).
Other Anthropogenic Sources	- Degradation of leaked or spilled hydrocarbons or other industrial chemicals; - Anaerobic degradation of organic contaminants in groundwaters (e.g., silage liquor); - Reactions between monitoring well construction components and environment; - Burial grounds/cemeteries.	Hydrocarbon spillages often have an 'oily' odour. Fuel spillages common – Petrol or Diesel and can contain a wide range of VOC's. Can degrade to produce methane / carbon dioxide.
Alluvium / Marsh / Peat Gas	Anaerobic microbial degradation of organic material (usually waterlogged vegetation / peat). Often associated with the presence of alluvial deposits or dredgings.	
Geogenic Gas	Natural seepages of carbon dioxide and hydrocarbon gases derived from geologic sources such as coal seams and deep oil / gas source formations. Can be present in solution in groundwaters.	Methane most common but can contain carbon dioxide and higher alkanes.
Mine Gases	Various types. Most common is "fire damp" with high methane, produced by the desorption of gas trapped in coal. "Black damp" (Stythe gas) with high carbon dioxide and denser than air. "White damp" is high in carbon monoxide.	Methane most common. Can contain higher alkanes, carbon dioxide and carbon monoxide. Often low in oxygen.
Natural Shallow Ground Gas	Various types - high carbon dioxide formed by subsurface aerobic activity leading to depleted oxygen and elevated carbon dioxide; - chemical degradation of rocks (e.g., carbonates) producing carbon dioxide; - carbon dioxide production in root zone of soils by plants.	Gases can be emitted from ground under falling barometric pressure conditions.

This Appendix concentrates on the assessment of risk from methane and carbon dioxide. This Appendix does not provide guidance for the assessment of risk when other gases are present due to 'Other Sources' from the above table (particularly organic compounds such as BTEX and VOC's or for the risk from radon or hydrogen sulphide).

To determine the origin of the gas a range of factors must be considered together, including;

1. Proximity of likely sources;
2. Ground conditions (geology, hydrogeology, anthropogenic pathways etc);
3. Properties of gases present including:
 - a. Chemical composition;
 - b. Physical properties;
 - c. Ratios of components e.g., methane : carbon dioxide.
4. Timeframe of activities such as infilling periods, capping works, installation of gas control systems etc.

Identification of the originating source may be problematic given that there may be more than one source present and trace gas analysis may be required. Identification of the sources of the gases encountered during monitoring is usually carried out through a process of eliminating the most unlikely potential sources (given the site setting) and selecting those which are the more likely candidates.

Hazards Associated with Presence of Ground Gases

Methane gas is combustible and potentially explosive. When the concentration of methane in air is between the limits of 5.0%v/v and 15.0%v/v an explosive mixture is formed. The Lower Explosive Limit (LEL) of methane is 5.0%v/v, which is equivalent to 100% LEL. The 15.0%v/v limit is known as the Upper Explosive Limit (UEL), but concentrations above this level cannot be assumed to represent safe concentrations. Further, the LEL and UEL will vary (up and down) depending upon the proportion of other gases (including oxygen). However, the fact that methane is a colourless, odourless gas means that there is no simple indicator of the presence of the gas until such a time as explosive limits are reached, and an incident occurs. Methane is lighter than air and has a low toxicity. However, at high concentrations it can result in asphyxiation due to oxygen displacement.

Carbon dioxide is a colourless, odourless gas, which, although non-flammable, is both toxic and an asphyxiant. As carbon dioxide is denser than air, it will collect in low points and depressions. The UK Health & Safety Executive (HSE) has published information relating to concentrations of carbon dioxide that humans may be exposed to, which uses concentrations contained in the Control of Substances Hazardous to Health Regulations 2002 (as amended). These are the Long-Term Occupational Exposure Limit (LTOEL, 8-hour period) and the Short-Term Occupational Exposure Limit (STOEL, 15-minute period), which are 0.5% and 1.5% carbon dioxide, respectively.

Parameters Influencing the Rate of Ground Gas Production

Figure G2 is taken from EA guidance document LFTGN 03 illustrates typical ground gas generation curves from biodegradable materials:

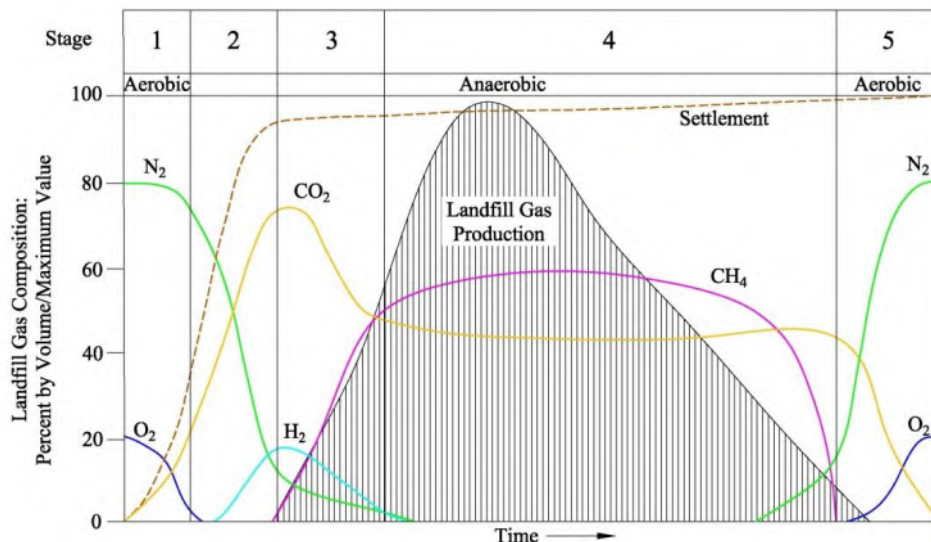


Figure G2. Idealised Representation of Landfill Gas Generation.

The production of methane and carbon dioxide at a landfill site may be expected to be considerable and ongoing. Concentrations of methane will eventually decrease, followed by concentrations of carbon dioxide, but the duration and rate of gas production can vary markedly between sites. Five distinct phases of gas production occur during the process which are, in order of event (as marked on Figure G2), as follows:

1. An aerobic phase involving oxygen depletion and temperature increase through aerobic respiration;
2. The establishment of anaerobic conditions and the evolution of carbon dioxide and hydrogen through acidogenic activity;
3. Commencement of methanogenic activity; the establishment of populations of methanogenic bacteria;
4. A phase of stable methanogenic activity, which may go on for many tens of years;
5. A phase of decreasing methanogenic activity, representing depletion of the organic material and a return to aerobic conditions.

The time scale for the return to the normal ground gas concentrations will be highly variable, depending upon the types and quantities of materials present. In addition, the optimum parameters influencing the rate of decomposition and ground gas production within the ground at a site are as follows:

- High water content with adequate rainfall and water infiltration to provide moisture content between approximately 20 to 26%;

- Conditions that either are or are very close to anaerobic;
- High proportion of biodegradable materials;
- A pH between 6.5 and 8.5, ideally verging slightly on the acidic between pH 6 to 7;
- Temperature between 25°C and 55°C;
- The ratio of the biochemical and chemical oxygen demands (BOD:COD);
- High permeability;
- Small particle size, as finer subsurface materials possess a greater surface area to provide a growing 'face' for the micro-organisms but high fines levels reduces permeability and reduces decomposition rate.

For this reason, it is vital that sources of methane and carbon dioxide are identified prior to the commencement of any work on a construction site, and that the ground gas regime is characterised at the worst temporal conditions a site may experience. From this, a risk assessment is carried out to identify the risk at the site from ground gases so that suitable protection measures can be designed and incorporated into a development to prevent a dangerous build-up of gas occurring.

Factors Influencing the Migration and Behaviour of Ground Gases

There are many factors that influence the migration of ground gases which can affect the risk from a gassing source:

- driving force – pressure differential along a pathway, diffusion and dissolved in solution;
- meteorological conditions – short term and seasonal conditions including atmospheric pressure changes (e.g., rapidly falling pressure causes gas to expand increasing emission rates), rainfall, frozen ground and thawing, temperature;
- geological and groundwater conditions – these can have the over-riding influence on the direction/pathways and quantity of migrating gas;
- anthropogenic influences – man-made pathways include mine shafts, service runs/drains, foundation piles, underground voids/pits/basements, foundation/building design/construction

Guidance Documents

Currently in the UK, there are no statutory threshold limits for hazardous gases in the ground as site specific variables mean that standard threshold values cannot be applied. The published guidance relating to development of sites where methane and carbon dioxide are present has been produced in response to building projects on or close to landfill sites, as both gases are principal constituents of landfill gas. Much of the historic guidance that has been produced on gas risk assessment focused on landfill sites and as a result there has previously been a lack of clarity when relating the process to gas conditions on non-landfill sites.

Statutory guidance regarding methane in the ground has previously taken a limiting concentration of 1.0 % by volume methane (equal to 20% of the lower explosive limit of methane in air) above which necessary actions will be appropriate. For carbon dioxide the limiting recommended trigger was 1.5 % by volume (the Long-Term Exposure Limit for carbon dioxide). Above these concentrations the Building Regulations Approved Document C (1992) stated that consideration should be given to whether actions may be appropriate, whilst more specific solutions would be likely to be necessary at concentrations greater than 5% by volume of carbon dioxide (Building Regulations Approved Document C, 1992). However, the latest fully revised version of Approved Document C (DoE, 2004) no longer endorses this approach and instead requires the use of a risk-based approach in interpreting the findings of a gas monitoring survey. Further, the latest EA documentation on landfill gas (LFTGN 03, 2004) continues to sanction the use of a risk-based approach through a structured approach to the assessment of ground gases and links with the risk assessment process outlined within CLR 11 for soil contaminants.

With the above in mind, recent guidance has been produced in 2006 and 2007 with the aim of providing up to date advice in relation to residential and commercial development. The guidance does not address issues associated with gas derived from landfills, for this refer to “*Guidance on the Management of Landfill Gas*” (Environment Agency 2004) for an overview.

Recent guidance relevant to gas assessments for residential and commercial development includes;

- **Wilson *et al.* (CIRIA C665, December 2007) “Assessing Risks Posed by Hazardous Ground Gases for Buildings.”**

This document provides up to date advice on all aspects of ground gas risk assessment such as investigation, monitoring programmes, data collection and interpretation. The guidance presents separate methodologies for the characterisation of:

- **All development types except low rise housing with gardens and for Low Rise Buildings without a 150mm void** (Situation A) (Table 8.5 CIRIA C665)
- and;
- **Low rise housing with gardens with a 150mm ventilated sub-floor void** (Situation B) (Table 8.7 CIRIA C665)
- (See below for further explanation of the methods of characterisation)

- **Boyle and Witherington (NHBC / RSK Group, Report 10627-R01(04) January 2007) “Guidance on the Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present.”**

This document presents the “Traffic Lights System” detailed below and is relevant only for low rise properties (e.g., bungalows and town houses) that have a ventilated sub-floor void (i.e., Situation B as described in CIRIA C665).

- **Wilson and Card (CIEH, expected 2011) “Ground Gas Handbook for Designers and Regulators”**

This document is expected to provide practical guidance on ground gas assessments and the design and evaluation of protection measures.

- **British Standard (BS 8485+A1, January 2019) “Code of Practice for the Design of Protective Measures for Methane and Carbon Dioxide Ground Gases for New Buildings”**

This document provides an overview of gas characterisation and assessment. The Standard is intended to be used by designers of gas protection measures and regulators involved in the assessment of design solutions. The Standard provides a framework in line with CLR11 allowing designers to judge the adequacy of ground gas and related site investigation data. The document provides an approach to determine appropriate ground gas parameters that can be used to identify a range of possible construction solutions mitigating against the presence of ground gas on a development site.

Each of these documents continues to highlight the importance of, and give further guidance towards, carrying out a tiered risk-based decision-making process in accord with government policy on dealing with contamination from historic or natural sources and highlight the importance of the Conceptual Model in site characterisation. These documents also stress the importance that the assessor should be confident that the ground gas monitoring results are representative of the likely worse case ground gas regime on a site and that the data collected from the site is sufficient. With this in mind, CIRIA C665 sets out ideal monitoring periods as below.

Idealised Frequency and Period of Monitoring (after Table 5.5a and 5.5b, CIRIA C665)						
		Generation Potential of Source				
		Very Low	Low	Moderate	High	Very High
Sensitivity of Development	Low (Commercial)	4/1	6/2	6/3	12/6	12/12
	Moderate (Flats)	6/2	6/3	9/6	12/12	24/24
	High (Residential with Gardens)	6/3	9/6	12/6	24/12	24/24
Notes 1. First number is the number of readings and the second is the minimum period in months (e.g., 6/2 – six sets of readings over two months). 2. At least two sets of readings must be at low (preferably under 1,000 mb) and falling pressure. 3. High sensitivity end use on high or very high hazard site will not normally be acceptable unless the source is treated to reduce gassing potential.						

Before the latest guidance, good practice for site characterisation had been based upon the method proposed by Wilson and Card (1999). CIRIA C665 (2007) effectively supersedes Wilson and Card (1999) and includes a modified version of the Wilson and Card method (Tables 8.5, 8.6 and Box 8.1). Gas concentrations and flow rates for either methane and/or carbon dioxide measured at a site to ‘Characteristic Situations.’ Appropriate protection measures are selected from Table 8.6 (if using modified Wilson & Card method) and from Box 8.4 from CIRIA C665 (if using the NHBC traffic lights method). Throughout the risk assessment process, strong regard must be given to the nature of the gassing source, the flow rates and the estimated surface emissions. Note that certain protection measures are stated in CIRIA Report 149 that are now considered wholly inappropriate to certain developments and consequently should not be used without modification. Throughout the process, it is important to remember that these tables are not

intended to be used as a definitive design tool and have been prepared to show the typical scope of measures for gas control.

Both the NHBC (2007) and CIRIA (2007) guidance documents and BS 8485+A1 (2019) propose that both ground gas concentrations and flow rates are used to calculate the limiting gas well gas volume flow rates for methane and carbon dioxide, based on the ground gas conditions monitored for during the worse-case temporal conditions. This limiting gas well volume flow rate is termed the Gas Screening Value (GSV, note that this was termed borehole gas volume flow), and is calculated as follows:

$$\text{GSV (l/hr)} = \frac{[\text{gas well gas concentration (\%v/v)}] \times [\text{gas well flow rate (l/hr)}]}{100}$$

These GSVs are then compared to generic 'Traffic Lights' contained within the NHBC guidance, which present typical maximum gas concentrations and limiting GSV's, for 'Situation B Development' (Low rise housing with gardens).

Table 8.7 NHBC Traffic light system for 150 mm void				
Traffic Light	Methane ¹		Carbon Dioxide ²	
	Typical max concentration ³ (% by volume)	Gas Screening Value ^{2,4} (litres/hour)	Typical max concentration ³ (% by volume)	Gas Screening Value ^{2,4} (litres/hour)
Green	1	0.13	5	0.78
Amber 1	5	0.63	10	1.6
Amber 2	20	1.60	30	3.10
Red				
Notes: 1. The worst-case ground gas regime identified on the site, either methane or carbon dioxide, at the worst-case temporal conditions that the site may be expected to encounter will be the decider as to what Traffic Light is allocated; 2. Borehole Gas Volume Flow Rate, in litres per hour as defined in Wilson and Card (1999), is the borehole flow rate multiplied by the concentration in the air stream of the particular gas being considered; 3. The Typical Maximum Concentrations can be exceeded in certain circumstances should the Conceptual Site Model indicate it is safe to do so; 4. The Gas Screening Value thresholds should not generally be exceeded without the completion of a detailed ground gas risk assessment taking into account site-specific conditions.				

Box 8.4 of CIRIA C665 Gas protection measures for low-rise housing development based upon allocated NHBC Traffic light (Boyle and Witherington, 2007)	
Traffic Light Classification	Protection Measures Required
Green	Negligible gas regime identified, and gas protection measures are not considered necessary.
Amber 1	Low to intermediate gas regime identified, which requires low-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to limit the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours.
Amber 2	Intermediate to high gas regime identified, which requires high-level gas protection measures, comprising a membrane and ventilated sub-floor void to create a permeability contrast to prevent the ingress of gas into buildings. Gas protection measures should be as prescribed in BRE Report 414. Membranes should always be fitted by a specialist Contractor. As with Amber 1, ventilation of the sub-floor void should facilitate a minimum of one complete volume change per 24 hours. Certification that these passive protection measures have been installed correctly should be provided.
Red	High gas regime identified. It is considered that standard residential housing would not normally be acceptable without a further Gas Risk Assessment and/or possible remedial mitigation measures to reduce and/or remove the source of gas.

For a 'Situation A Development' (All development except low rise housing with gardens), the GSV value is used to derive the appropriate Characteristic Situation from Table 8.5 of CIRIA C665 (below):

Table 8.5 from CIRIA C665 Modified Wilson and Card Classification					
Characteristic Situation (CIRIA R149)	Comparable Partners in Technology gas Regime (see Box 8.2)	Risk Classification	Gas Screening Value (CH ₄ or CO ₂) (l/hr) ¹	Additional Factors	Typical Source of Generation
1	A	Very low risk	<0.07	Typically, methane ≤ 1% and/or carbon dioxide ≤ 5%. Otherwise consider increase to Situation 2	Natural soils with low organic content "Typical" made ground
2	B	Low risk	<0.7	Borehole air flow rate not to exceed 70l/hr. Otherwise consider increase to characteristic Situation 3	Natural soil, high peat/organic content. "Typical" made ground
3	C	Moderate risk	<3.5		Old landfill, inert waste, mine working flooded
4	D	Moderate to high risk	<15	Quantitative risk assessment required to evaluate scope of protective measures.	Mine working susceptible to flooding, completed landfill (WMP 26B criteria)
5	E	High risk	<70		Mine working unflooded inactive with shallow workings near surface
6	F	Very high risk	>70		Recent landfill site

It was intended in CIRIA C665 that the characteristic situation allocated to the development from the table above would then be used in Table 8.6 of CIRIA C665 in order to determine the level of gas protection the development requires. However, BS8485:2015 superseded this document and a different set of mitigation standards were put forward.

The recommended minimum gas protection score (points) be selected based on the building type (Table 3 which defines four building types) and the ground gas Characteristic Situation as detailed in Table 4 of BS8485:2015+A1:2019 (see below).

The first step in the decision-making process is to obtain the level of gas protection necessary in the range 0 to 7.5 from Table 4. Then a combination of structural barriers (Table 5) ventilation protection measures (Table 6) and/or gas resistant membranes (Table 8) should be chosen to meet that requirement. The level of gas protection necessary should take into account the characteristic gas situation and a number of other factors. The whole decision-making process should be made transparent, where all parties can see the approach being taken, can understand the various steps and decisions made and be confident that a risk-assessed solution has been designed and installed commensurate with the construction and site constraints.

Where the gas Characteristic Situation is 4 or more (and for NHBC Red situations according to CIRIA C665), the site requires a comprehensive risk assessment to confirm the scope of protection measures. These are higher risk sites and reliance on Table 4 alone is not sufficient.

BS8485:2015+A1:2019 Table 3 Building Types				
	Type A	Type B	Type C	Type D
Ownership	Private	Private or commercial/ public, possible multiple	Commercial / public	Commercial / industrial
Control (change of use, structural alterations, ventilation	None	Some but not all	Full	Full
Room sizes	Small	Small / medium	Small to large	Large industrial / retail park style

BS8485:2015+A1:2019 Table 4 Gas Protection Score by CS and Type of Building				
CS	Required Gas Protection			
	High risk	Medium risk	Low risk	
	Type A	Type B	Type C	Type D
1	0	0	0	0
2	3.5	3.5	2.5	1.5
3	4.5	4	3	2.5
4	6.5 ^(A)	5.5 ^(A)	4.5	3.5
5	^(B)	6 ^(A)	5.5	4.5
6	^(B)	^(B)	^(B)	6
a)	Residential building should not be built on CS4 or higher sites unless the type of construction or site circumstances allow additional levels of protection to be incorporated, e.g., high-performance ventilation or pathway intervention measures, and an associated sustainable system of management of maintenance of the gas control system, e.g., in institutional and/or fully serviced contractual situations.			
b)	The gas hazard is too high for this empirical method to be used to define the gas protection measures			
^{NOTE 3} The NHBC has published guidance for use on residential developments, which utilise an alternative classification (“traffic light”) system. This guidance typically applies to Type A buildings utilising beam and block floor constructions with clear void ventilation. The design choice variables are limited to decisions relating to the membrane specification and verification recommendations (see Table 7). Designers utilising this system would therefore need to refer to NHBC to assess compliance for specific recommendations [see 8485:2015 for further on this note]				
^{NOTE 4} The method of selecting the combination of these types of protection is given in section 7.2 of BS8485:2015. Once type of measures has been decided, the detailed design and specification of the measures should be undertaken (section 7.3)				

Section 7.2 defines the order of selecting protective measures. The first choice is provided by structural barriers as defined in Table 5.

BS8485+A1:2019 Table 5 Gas protection scores for structural barriers		
PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
Floor and substructure design		
Floor slabs		
Block and beam floor slab	0	<i>General – score conditional that breaches of slab are sealed</i>
Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement)	0.5	
Cast in situ monolithic reinforced ground-bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations (with only nominal mesh reinforcement)	1 or 1.5	<i>To achieve 1.5, raft or suspended slab to be well reinforced to prevent cracking and minimal penetrations</i>
Basement floor and walls to BS 8102:2009, Grade 2 waterproofing – See notes in BS8485:2015+A1:2019	2	
Basement floor and walls to BS 8102:2009, Grade 3 waterproofing – See notes in BS8485:2015+A1:2019	2.5	<i>Conditional that waterproofing is not based on geosynthetic clay liner</i>

Ventilation methods are detailed in Table 6, and points can only be gained from using one of the five types:

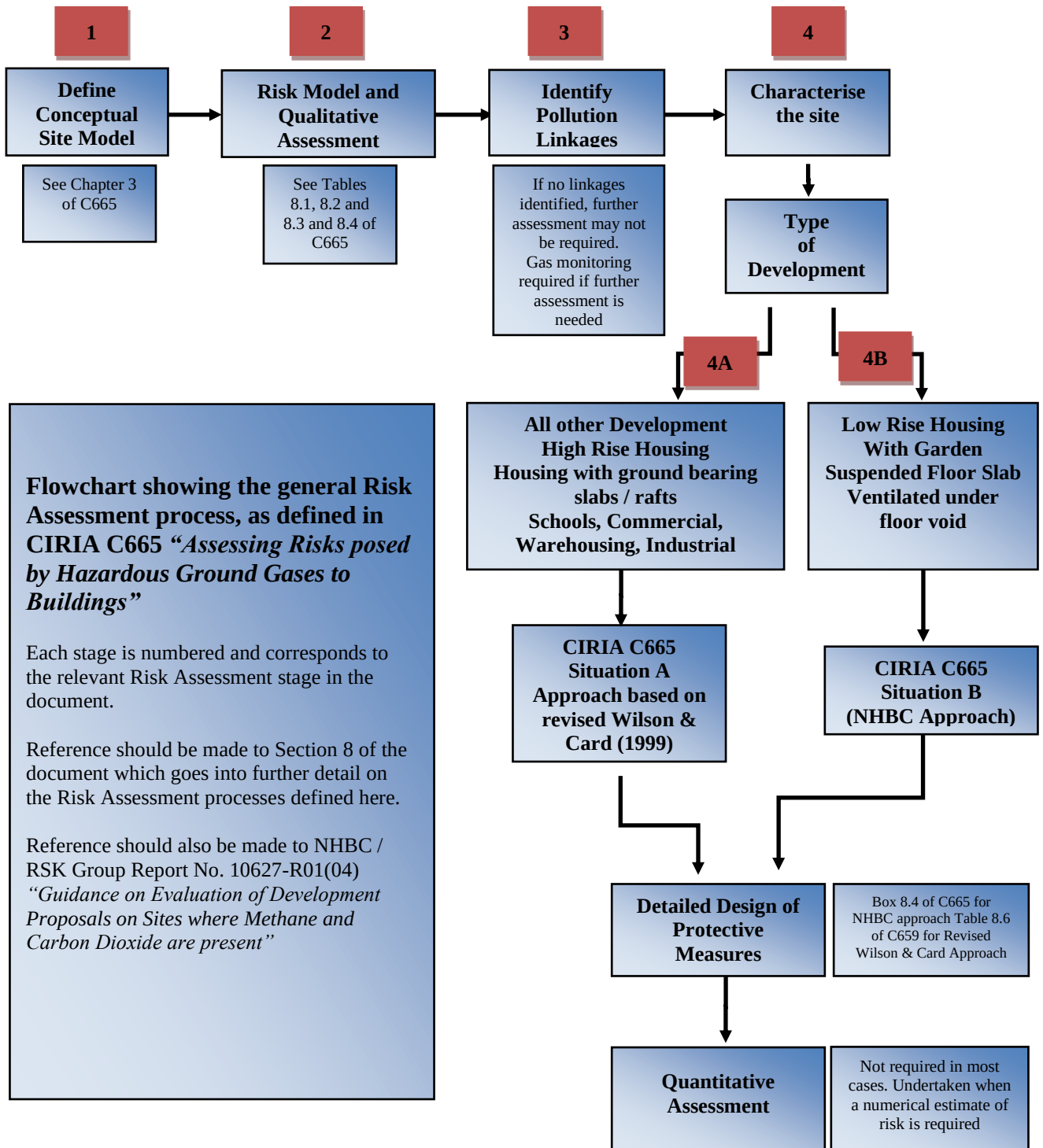
BS8485:2015+A1:2019 Table 6 Gas Protection Scores for Ventilation Protection Measures		
PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
a) Pressure relief pathway (usually formed by low fines gravel or with a thin geocomposite blanket with strips terminating in a gravel trench external to the building)	0.5	<i>Whenever possible, a pressure pathway relief pathway (as a minimum) should be installed in all gas protection measures systems. If a layer has a low permeability and/or is not terminating in a venting trench (or similar), then the score is zero.</i>
b) Passive sub floor dispersal layer		
Very good performance	2.5	<i>Performance criteria shown in Fig B.6 and B.7 of BS 8484:2015.[See Annex B]</i>
Good performance	1.5	
Media used to provide the dispersal layer are:		
• Clear void • Polystyrene void forming blanket • Geocomposite void former blanket • No-fines gravel layer with gas drains • No-fines gravel layer		
c) Active dispersal layer, usually comprising fans with active abstraction (suction) from a subfloor dilution layer, with roof level vents. The dilution layer may comprise a clear void or be formed of geocomposite or polystyrene void formers	1.5 to 2.5	<i>This system relies on continued serviceability of the pumps; therefore, alarm and response systems should be in place. [See Annex B].</i>
d) Active positive pressurisation by the creation of a blanket of external fresh air beneath the building floor slab by pumps supplying air to points across the central footprint of the building into a permeable layer, usually formed of a thin geocomposite blanket	1.5 to 2.5	<i>This system relies on continued operation of the pumps; therefore, alarm and response systems should be in place. [See Annex B].</i>
e) Ventilated car park (floor slab of occupied part of the building under consideration is underlain by a basement or undercroft)	4	<i>Assumes car park is vented , designed to Building Regulations 2000, Approved Document F.</i>

Membrane methods are detailed in Table 7.

BS8485:2015+A1:2019 Table 7 Gas protection score for gas resistant membrane		
PROTECTION ELEMENT/SYSTEM	SCORE	COMMENTS
Gas resistant membrane meeting all of the following criteria: • Sufficiently impervious to gases with a methane gas transmission rate $<40.0 \text{ ml/day/m}^2/\text{atm}$ (average) for sheet and joints (tested in accordance with BS ISO 15105-1 manometric method) • Sufficiently durable to remain serviceable for the anticipated life of the building and duration of gas emissions; • Sufficiently strong to withstand in-service stresses (e.g., settlement if placed below a floor slab); • Sufficiently strong to withstand the installation process and following trades until covered (e.g., penetration from steel fibres in fibre reinforced concrete, dropping tools etc); and to withstand in-service stresses (e.g., settlement if placed below a floor slab) • capable, after installation, of providing a complete barrier to the entry of the relevant gas; and • verified in accordance with CIRIA C735	2	<i>The performance of membranes is heavily dependent on the quality and design of the installation, resistance to damage after installation, and the integrity of joints.</i> <i>If a membrane is installed that does not meet the criteria, then the score is zero.</i>
See notes in BS8485:2015+A1:2019 regarding membrane requirements		

For a site which is impacted by migratory gases from an off source, the development may be protected by imposing pathway intervention methods, which if successfully validated, could also remove the need for further analysis. It is essential that the gas regime in these circumstances has been fully characterised and that the only source impacting the site is located off site and that the pathway is clearly defined and its interception equally proven before construction commences. Pathway intervention methods may include vertical membrane installations, venting trenches, rows of stone columns, activated trenches and various proprietary systems. These systems are particularly relevant to domestic housing where there is limited scope for foundation type solutions.

Following the choice of protection measures, detailed design should be entered into [Section 8 of BS 8485:2015+A1:2019].



APPENDIX H – GUIDANCE FOR CLASSIFICATION OF SOIL FOR OFF SITE DISPOSAL AT A LANDFILL SITE

Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

Many site developments create a portion of excess soils and Made Ground which if not re-usable, are required to be disposed off-site at a suitably licensed landfill site. The regulations and associated guidance published by the Environment Agency is relatively complex and lengthy. This guidance provides a summary of the following documents which should be referred to when assessing soil (and common constituents found within Made Ground on remediation sites) for off-site disposal:

- Guidance for Waste destined for disposal in landfills: Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended) (EA, 2004);
- Guidance on Sampling and Testing of Wastes to Meet Landfill Waste Acceptance Procedures (EA, April 2005);
- WM3 - Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Wastes (EA, May 2015);
- European Regulation No 1272/2008 on Classification, Labelling and Packaging of substances 2015 (CLP 2015);
- Guidance on Waste Destined for Disposal in Landfill (EA, June 2006);
- Treatment of Non-hazardous wastes for Landfill (EA, February 2007).

It is important to distinguish between the waste classification system and the designation of materials as “suitable for use” on site. A material may be retained on site for an appropriate end use if that end-use is clearly designated and that a site-specific risk assessment ensures that it does not pose a risk to human health or controlled waters. However, if this material is excavated and sent for disposal, the material is then subject to waste management regulations and the two systems cannot be directly correlated. It is therefore important to note that classifying a material as hazardous (should it be excavated and become a waste) does not necessarily indicate that it might not be suitable to be kept on site for re-use. Separate guidance in the form of a Code of Practice (CL:AIRE Version 2, 2011) has been developed jointly between the development industry and the Environment Agency to provide best practice when assessing whether materials are wastes or not, and for determining when waste can cease to be waste for a particular use.

In accordance with the current waste regulations (or Landfill Directive, as they are more commonly known), from 30th October 2007 all waste materials produced from construction sites have to be pre-treated prior to disposal. Pre-treatment includes waste minimisation, recovery (e.g., separation of demolition waste to be used as hardcore) and separation of materials into different waste categories (e.g., separate inert waste from hazardous waste etc). Mixing of different waste types shall be avoided and intentional mixing of inert materials with hazardous waste to ‘dilute it’ and hence change its waste classification, is illegal.

The current waste regulations (based on the EU landfill directive) introduced a two-tier classification system for waste materials, defining them as either being hazardous or non-hazardous. Landfills are licensed to take wastes based on a three-tier classification system with the non- hazardous waste divided into two sub-categories:

- Non-Hazardous - inert;
- Non-Hazardous - non-hazardous;
- Hazardous.

Waste materials are categorised with a six-figure numeric code in the European Waste Catalogue. Commonly found construction and demolition wastes including excavated soil from contaminated sites and Made Ground with their waste codes are summarised below (this is not a comprehensive list):

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 01 01 Concrete	Concrete, possibly with reinforcement (from Construction & Demolition)	✓		
17 01 02 Bricks		✓		
17 01 06* Mixtures of concrete, bricks, tiles & ceramics containing dangerous substances	These are not normally considered hazardous but if they are contaminated (e.g., by asbestos) then could be hazardous – see comment above			✓
17 01 07 Mixtures of concrete, bricks, tiles & ceramics other than those in 17 01 06	This is mixed inerts c.f. 17 09 04	✓		
17 05 03* soils and stones containing dangerous substances				✓
17 05 04 soils and stones other than those mentioned in 17 05 03	Soil and stones only (excluding top soil, peat, soil and stones from contaminated sites)	✓		
17 06 05* Construction materials containing asbestos	e.g., corrugated asbestos sheeting			✓
17 08 02 Gypsum-based construction materials other than those mentioned in 17 08 01	Plaster & plasterboard (although specific disposal requirements are required for high sulphate waste – see EA guidance ‘Understanding the Landfill Directive’ version 1.0 March 2010.		✓	
17 09 01* Construction & demolition wastes containing mercury				✓
17 09 02* Construction & demolition wastes containing PCBs	Waste with more than 50 mg/kg of PCB’s are hazardous			✓

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 09 03* Other mixed construction & demolition wastes containing dangerous substances	Broad range of potentially (see notes below – if asterix the waste is hazardous) hazardous wastes			✓
17 09 04 Mixed construction & demolition wastes other than those mentioned in 17 09 01, 17 09 02 & 17 09 03	Mixed inerts with soil, tarmac, cables, vegetation, plaster, etc. (this waste can only be considered inert if it passes the waste acceptance criteria identified in the regulations).	✓	✓	

Note: all wastes with an asterix code are hazardous regardless of whether they are mirror or absolute entries in the EWC list the decision to with regard to composition must come before applying the code for mirror entries.

Some materials are classified as Inert Waste based in its origin (e.g., 17 01 01 Concrete, or glass) without any requirement for laboratory chemical analysis.

However, most soils will require laboratory testing to confirm whether they are classified as Hazardous Waste. The protocol for assessing these materials and the appropriate threshold values is complicated and are set out in the Environment Agency’s “Technical Guidance WM3 Hazardous Waste – Interpretation of the Definition and Classification of Hazardous Waste” (2015). If the test results for the waste indicates that it is not hazardous then further analysis of the waste is required to determine whether it is Inert Waste. If the waste does not meet the criteria for either Hazardous or Inert, then it is by default classified as Non-hazardous Waste.

As an alternative location to landfills for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Waste Permit Exemptions that can accept certain categories of inert and non-hazardous wastes. Additionally, some quarries can accept certain types of wastes to be used for quarry restoration material. For both alternatives to disposal at landfill sites the material still requires chemical testing as these sites have site specific acceptance criteria for wastes. It should also be noted that these types of sites do not incur landfill tax which in the 2022/23 tax year is £3.25 for inactive waste (inert and some types of non-hazardous waste) and £102.20/Tonne for active waste (some types of non-hazardous waste and hazardous waste). For 2024/25 the corresponding rates will be £3.30 and £103.70/Tonne. Note that the Inland Revenue uses a different classification scheme for waste for tax purposes to the European Waste Classification scheme.

Waste Categorisation

The process of determining the category of wastes is a three-stage process:

- Stage 1 – is the waste either Hazardous or Inert by definition without the requirement for chemical analysis (if it is then Stages 2 and 3 are not required);
- Stage 2 - Waste characterisation;
- Stage 3 - WAC classification.

Waste characterisation determines if a waste is hazardous or not. Excavated soil is characterised using a system based on the contaminants present and their hazardous properties. The system uses total concentrations of the contaminants. Thresholds (as a percentage of the waste) have been set for the various hazardous properties.

Fourteen hazardous properties together with other scenarios where material could cause a hazard have been defined:

- Hazardous properties: explosive, oxidising, highly flammable/flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, toxic for reproduction, mutagenic and ecotoxic;
- Substances which can release toxic/very toxic gases in contact with water, acid or air;
- Substances which, after disposal, can yield another substance, e.g., a leachate, which possesses any of the above hazardous properties.

Some of the hazardous properties are sub-divided e.g., there are three categories of carcinogenic, mutagenic and toxic for reproduction substances. The hazardous properties were originally defined in the European Hazardous Waste Directive 91/689/EC. Should a waste contain a contaminant with one or more of the listed hazardous properties at a concentration equal to or above the threshold value for the particular property, then the waste is hazardous. The hazardous properties of a wide range of chemicals are sourced from CLP 2015.

There are many reasons why waste soil is classified as being hazardous, but the majority of reasons can be divided into the following four groups:

- Hydrocarbons – this is probably the most common reason for the hazardous classification of soils. For most soils hydrocarbon analysis will be required for both Polycyclic Aromatic Hydrocarbons (PAH) and speciated Petroleum Hydrocarbons (PHCs) but depending on the site's history other groups of organic contaminants may also be included in any analysis suite for soil samples;
- Metals – Particularly sites from former metal processing or mining sites and also some types of ash have metal concentrations that are sufficiently high to characterise materials requiring disposal as hazardous waste.
- Asbestos;
- Anions – e.g., sulphate in plasterboard (there are special disposal requirements for high sulphate waste and specific WAC requirements); it is possible that sulphate salts of metals and semi-metals could make the waste hazardous – the sulphate concentration could possibly be significant under H12, H13 and H14.

The characterisation of wastes with significant metal concentrations involves some processing of the analysis data. The chemical analysis results for inorganic substances are generally reported as total concentrations e.g., total lead, total arsenic, total sulphate etc. However, CLP 2015 deals with the hazardous properties of actual compounds e.g., lead sulphate, arsenic pentoxide, nickel carbonate. Therefore, the total metal results have to be converted into assessed chemical analysis results for the compound most likely to be present in the soil samples. For example, if the sample contains high total lead concentrations and high sulphate concentrations, then the lead is likely to be present

in the soil as lead sulphate. The most likely compounds can often be determined from a desk study or previous site uses. If the site has been derelict for a number of years, consideration should be given as to whether water soluble compounds should or should not be chosen, as rainfall could have removed them from the soil (this does not apply if the soil has been taken from below under a concrete slab etc). Chemical knowledge and common sense needs to be used in choosing a suitable compound.

If no data is available, then a worst-case scenario has to be assumed and the most hazardous compound likely to be present has to be chosen. For example, metal chromates (lead chromate, nickel chromate) are often the most hazardous compounds formed by many metals, but if the chromium concentrations in the soil are low, chromates are unlikely to be present. It should also be noted that for many of the hazard categories, the cumulative hazard from different compounds is added (e.g., add the concentrations of the copper, lead and zinc compounds together to assess the Hazard Category H14 Ecotoxicity).

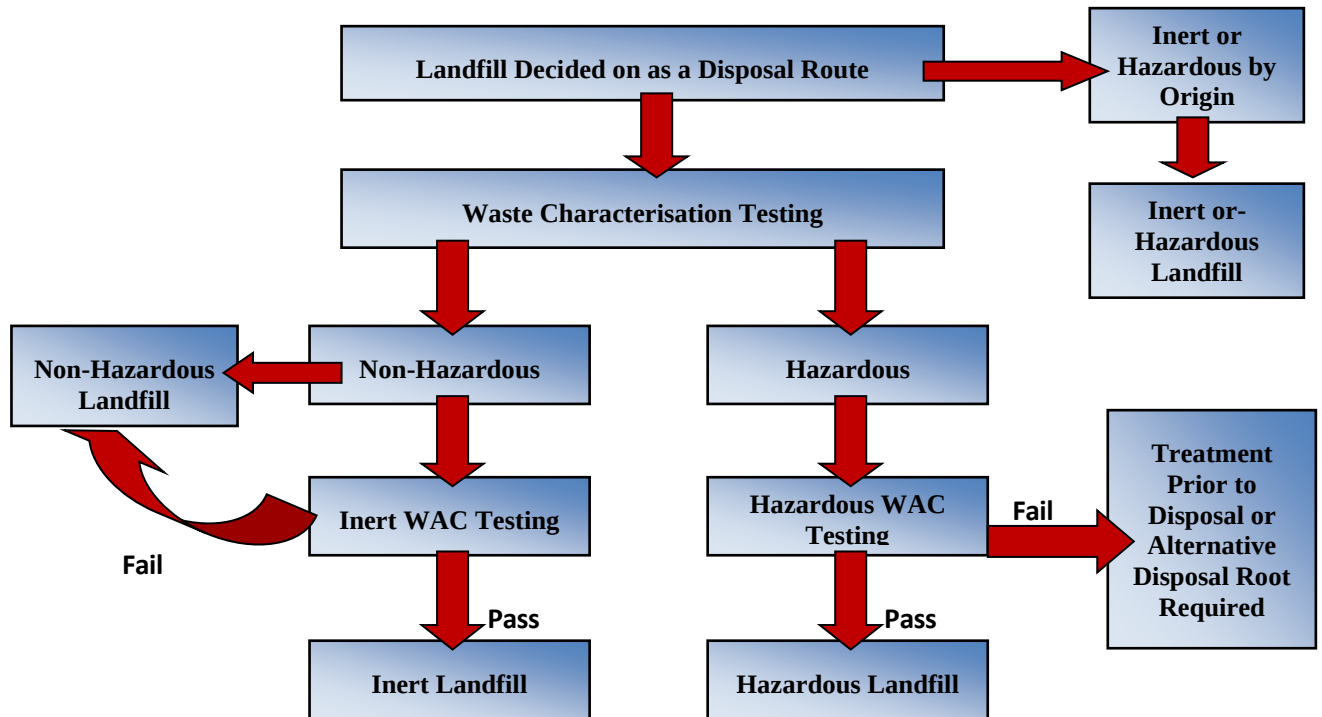
If the results of the above assessment determine that the waste is hazardous, it must then be analysed for the Waste Acceptance Criteria (WAC) analysis contained within appropriate Environmental Permitting Regulations (this comprises mainly leachate but also analysis for TOC and Loss on ignition). WAC limit values have been set for the listed determinands. If any of the determinands exceed their limit value, the waste must be pre-treated to reduce concentrations to below the limit values before the waste may be disposed of at a landfill site licensed to take hazardous waste.

For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively, WAC testing for Inert Waste can be carried out (this is similar to the list for hazardous waste with the addition of PAH's, BTEX and Mineral Oil). If the results pass the Inert WAC criteria it can be disposed of at an Inert Waste Landfill. If any of the WAC test results exceed the Inert WAC criteria the waste has to be disposed at a non-hazardous landfill. There are WAC limits for non-hazardous waste set for pH and TOC. If these two criteria are not met then the waste must be pre-treated so that it meets the criteria before it can be disposed.

If materials fail the WAC criteria it may be possible to pre-treat the waste on-site or be taken to a soil treatment centre for pre-treatment to reduce the soil's hazardous properties (e.g., by bioremediation of hydrocarbons).

It should be noted that in order to dispose of Hazardous Waste, the site must register as a producer of Hazardous Waste with the Environment Agency. When disposing of waste materials to landfill sites the appropriate Duty of Care Waste Transfer procedures must be followed.

Landfilled Waste Decision Tree



APPENDIX I – UNFORESEEN GROUND CONTAMINATION

Unforeseen Ground Contamination

There is the potential for areas of previously unexpected contamination to be present, as is the case with any “brownfield” site. Any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material should be considered in this category. If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination will cease.
2. A suitably trained geo-environmental specialist should assess the visual and olfactory observations of the condition of the ground and the extent of contamination, and the Client and the Local Authority should be informed of the discovery. Should the contamination be likely to affect controlled waters the Environment Agency shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance with the assessed risks. The investigation works will be carried out in the presence of a suitably qualified geo-environmental engineer. The investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, delineate the area over which contaminated materials are present.
4. The unexpected, contaminated material will either be left in situ or be stockpiled whilst testing is carried out and suitable assessments completed to determine whether the material can be re-used on site or requires to be disposed as appropriate.
5. Where the material is left in situ awaiting results it will be reburied or covered with plastic sheeting.
6. Where the potentially contaminated material is to be temporarily stockpiled it will either be placed either on a prepared surface of clayey Alluvium, or on 2000-gauge Visqueen sheeting (or other impermeable surface) and covered to prevent dust and odour emissions.
7. Any areas where unexpected visual or olfactory ground contamination will be surveyed, a photographic record kept, and testing results incorporated into the Verification Report.
8. A photographic recorded will be made of relevant observations.
9. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
10. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
11. The results of the investigation and testing of any suspect unexpected contamination will be used to determine the relevant actions. After consultation with the Local Authority and if necessary the Environment Agency, materials should either be:
 - re-used in areas where test results indicate that it meets compliance targets so it can be reused without treatment; or
 - treatment of material on site to meet compliance targets so it can be reused; or

- removal from site to a treatment centre or to a suitably licensed landfill or permitted treatment facility.

12. Verification Report will be produced for the work.

Asbestos

Asbestos cement products and asbestos fibres have not been encountered in the soils at the site but based on the age of the Made Ground material containing asbestos could be expected to be encountered. If non-notifiable asbestos (e.g., chrysotile asbestos cement board) is encountered in excavations then it will be dealt with in accordance with the Control of Asbestos Regulations 2012 (CAR 2012) and the HSE's ACoP for asbestos (2013). Finding non-notifiable asbestos is a very common occurrence on brownfield sites and is a relatively low risk activity and can be dealt with as a matter of routine. Therefore, it is not proposed that the Council will be notified but an appropriate record will be kept of confirmatory testing and disposal. This will be included in remediation verification reports.

If suspect notifiable asbestos is encountered then the Council and the HSE will be notified. An appropriate action plan will be agreed with the Council and the HSE in accordance with CAR 2012. The action plan will include the preparation of the Risk Assessment and Plan of Work in accordance with CAR and other statutory requirements including:

- Site mobilisation;
- Excavation methodology;
- Handling, movement and storage on-site of excavation arisings;
- Any processing of excavation arisings containing ACMs;
- Movement and placement of arisings to final destination;
- Placing of cover system over soils with and ACMs remaining on-site;
- Off-site disposal of ACMs;
- Licences;
- PPE & RPE; and,
- Dust and fibre monitoring.

Potential mitigation measures that would be required include:

- Ensuring works are carried out by suitably trained and experienced personnel with working with asbestos;
- Site investigation and risk assessment;
- Removal or treatment of asbestos hotspots;
- Use of PPE and RPE by construction workers; and,

- Compliance monitoring.

Unexpected Tanks

No buried underground fuel storage tanks have been encountered during the site investigation works; however, there remains a low risk that tanks are present on-site. Should an underground tank be encountered, operations should cease in the area. Additionally, there may be pipework associated with these tanks which could have oily residues. The following procedures are to be adhered to if tanks and pipework are identified:

1. All site works at the position of the tanks/pipework should stop.
2. A description of the tank should be made by the geo-environmental engineer including; condition and surround, along with visual and olfactory observations should any contents in the tank be apparent. A photographic record will also be made of relevant observations.
3. The tank's position and depth should be determined and marked on a plan of the site.
4. The independent geo-environmental engineer will inform Client and the Local Authority.
5. During the presence of the independent geo-environmental engineer, investigation works should be undertaken to obtain samples of any liquid or sludge contents and to establish dimensions of the tank.
6. Testing will be determined on the basis of visual and olfactory observations by independent geo-environmental engineer.
7. Test results will be compared against current assessment criteria and proposals for disposal of any contents determined in agreement with the appropriate Regulatory Parties.
8. Emptying the tank and disposal of contents to a suitable licenced disposal facility.
9. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided.
10. Once the tank has been emptied in accordance with the above proposals, it is to be removed for disposal to a licensed waste management facility. Copies of the relevant waste consignment notes are to be kept and included in the Verification Report.
11. Excavation and remediation of any contaminated soils around the tank will be carried out.
12. Samples of the base and sides of the resultant hole will be sampled and supervised by the independent geo-environmental engineer to confirm whether risks to human health or controlled waters.